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SCS Engineers, Long Beach, CA

Prepared for

Health Effects Resarch Lab., Research Triangle Park, NC

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Health Effects Associated with Wastewater Treatment and Disposal Systems State-of-the-Art Review

Volume II, Part 1

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This annotated bibliography covers the source documents used in the main text. For individual articles a brief summary of the major topics of discussion is presented. For major reports a short description of their content is provided. A subject index to the bibliography is provided at the back of Volume II, Part 2.

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HEALTH EFFECTS ASSOCIATED WITH WASTEWATER TREATMENT AND DISPOSAL SYSTEMS STATE-OF-THE-ART REVIEW

VOLUME II

ANNOTATED BIBLIOGRAPHY
PART I: A THROUGH L

by

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This report has been reviewed by the Health Effects Research Laboratory, U.S. Environmental Protection Agency, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

FOREWORD

The many benefits of our modern, developing, industrial society are accompanied by certain hazards. Careful assessment of the relative risk of existing and new man-made environmental hazards is necessary for the establishment of sound regulatory policy. These regulations serve to enhance the quality of our environment in order to promote the public health and welfare and the productive capacity of our Nation's population.

The Health Effects Research Laboratory, Research Triangle Park, conducts a coordinated environmental health research program in toxicology, epidemiology, and clinical studies using human volunteer subjects. These studies address problems in air pollution, non-ionizing radiation, environmental carcinogenesis and the toxicology of pesticides as well as other chemical pollutants. The Laboratory participates in the development and revision of air quality criteria documents on pollutants for which national ambient air quality standards exist or are proposed, provides the data for registration of new pesticides or proposed suspension of those already in use, conducts research on hazardous and toxic materials, and is primarily responsible for providing the health basis for non-ionizing radiation standards. Direct support to the regulatory function of the Agency is provided in the form of expert testimony and preparation of affidavits as well as expert advice to the Administrator to assure the adequacy of health care and surveillance of persons having suffered imminent and substantial endangerment of their health.

Pursuant to the overall mission of the laboratory to investigate the human health effects of environmental pollution, this contract was let to summarize the state of knowledge regarding the health effects associated with various methods of handling wastewaters and sewage sludges. Subjects of interest include biological as well as chemical pollutants. Pathways of these agents from wastewater streams to man were delineated.

F. G. Hueter, Ph.D.
Director
Health Effects Research Laboratory

ABSTRACT

This annotated bibliography covers the source documents used in the main text. For individual articles a brief summary of the major topics of discussion is presented. For major reports a short description of their content is provided. A subject index to the bibliography is provided at the back of Volume II, Part 2.

Aberg, B., L. Ekman, R. Falk, U. Greitz, G. Persson, and J. O. Snihs.

Metabolism of Methyl Mercury (203 Hg) Compounds in Man: Excretion and Distribution.

Archives of Environmental Health. 19(4):478-484. October 1969.

Key Words: epidemiology, mercury, environmental pathways.

Abstract:

The oral intake of 2.6μCi of methyl-mercuric nitrate Hg 203 by three clinically healthy, white, male volunteers aged 37 to 44 years resulted in an accumulation in the liver and the head of the ^{203}Hg. The main excretory route was the feces, but the urinary excretion increased with time up to 30 days after the intake. The biological half-life was found with whole body measurements to be 70 to 74 days. The decline of ^{203}Hg in the head was less rapid than in the rest of the body. No ^{203}Hg was found in the sperm. A very rapid uptake was found in the erythrocytes. The main activity was localized in the liver (about 50 percent of the contents of the body) whereas the head contained about 10 percent of the total body content.

Adams, A.P. and J.C. Spendlove.

Coliform Aerosols Emitted by Sewage Treatment Plants.

Science. 169(3951):1218-1220. September 18, 1970.

Key Words: air, groundwater, coliforms, bacteria.

Abstract:

Development of the science of aerobiology has furnished a tool for the investigation of potential sources of microbial aerosols. An investigation of aerosols emitted by trickling-filter sewage treatment plants revealed that coliforms were indeed emitted and have been sampled to a distance of 0.8 mi (1.2 km) downwind. Factors affecting survival of *Escherichia coli* are presented.

Adams, B.J. and R.S. Grimmell.

Performance of Regionally Related Wastewater Treatment Plants.

JWPCF. 45(10):2088-2163. October 1973.

Key Words: suspended solids, activated sludge.

Abstract:

The analyses of individual plant performance produced several interesting results. The analysis for trend indicated that there was little linear persistence in the data records. The regression coefficients calculated for effluent quality variables were very slightly negative, while those calculated for influent quality variables were positive with larger absolute values. Generally, the recorded trend over one year was small.

Adams, C.E.

Removing Nitrogen from Waste Water.

Environmental Science and Technology. 7(8):696-701.
August 1973.

Key Words: ammonia, nitrates, nitrification/denitrfication, activated sludge, trickling filters, anaerobic lagoons.

Abstract:

The forms of nitrogen most prevalent in waste waters, and which require treatment, are ammonia (as NH_4^+), nitrate (as NO_3^-), and organic nitrogen, for example, in the amine form. Many industrial wastes also contain nitrated organics which are extremely difficult to remove. The most practical technology for removing ammonia from waste waters includes biological synthesis and nitrification, ion exchange, air and steam stripping, and chlorination. Nitrates are best treated by biological denitrification and ion exchange. The organic forms of nitrogen may, in some cases, be removed by carbon adsorption, although generally biological synthesis and conversion to other more readily removed forms are more practical.

Adams, C.E., P.A. Krenkel, and E.C. Bingham.

Investigation into the Reduction of High Nitrogen Concentrations.

Advances in Water Pollution Research. 1970(1): 13/1-13.

Key Words: ammonia, nitrates, nitrification/denitrification, trickling filters.

Abstract:

The overall objective of this investigation was to evaluate the technical and economic feasibility of reducing high concentrations of nitrogen by use of conventional treatment techniques with appropriate variations. The waste in question evolved from a nitrogenous fertilizer plant and contained appreciable concentrations of nitrate-nitrogen and ammonia-nitrogen. The study was divided into a laboratory phase and a full-scale field phase. The laboratory studies are now complete; and the field studies, which are expected to last for approximately two years, are underway. The findings herein are inconclusive.

Adams, V.D., E.J. Middlebrooks, and P.D. Nance.

Organic Residue in a Recycled Effluent. Part I.

Water and Sewage Works. 122(6):82-84. September 1975.

Key Words: synthetic / organics, surface water, chemical treatment, chlorination.

Abstract:

The accumulation of organic compounds in the recycled effluents is discussed.

Adams, W. H., J. R. Buchholz, C. W. Christenson, G. L. Johnson, and E. B. Fowler.

Studies of Plutonium, Americium, and Uranium in Environmental Matrices.

Los Alamos Scientific Laboratory of the University of California, Los Alamos, N. M., January 1975. p. 24.

Key Words: uranium, groundwater, air, crops.

Abstract:

A nitric acid-hydrofluoric acid treatment for dissolution of plutonium oxides in soils has been developed; its adaption to other biological matrices is discussed. Plutonium recoveries of 94 to 99% from 1-g samples of spiked and heated soils are reported. Adaptation of the acid solution to subsequent anion exchange separation of plutonium, followed by coupling to known electroplating techniques, is described.

The uptake of plutonium, americium, and uranium from spiked soils by alfalfa, beans, radishes, lettuce, tomatoes, and barley is reported.

The "apparent" solubility of $^{238}PuO_2$ in tap water was measured; and the deposition of plutonium in fish, algae, and snails in aquaria containing $^{238}PuO_2$ microspheres is reported.

Advances in Wastewater Treatment, Pilot Plant, Pomona, California.

Federal Water Quality Administration, Cincinnati, Ohio, Advanced Wastewater Treatment Facility, February 1973. 19p. (Available through National Technical Information Service (NTIS) as PB-217 453).

Key Words: ammonia, phosphates, nitrification/denitrification, ozonation, chemical treatment, chlorination.

Abstract:

This publication provides an excellent background for writing about activated carbon,nitrification-denitrification, chlorination, ozonation, and physical-chemical treatment. Basically, this article is a proposal on research that is currently being conducted.

Advisory Report on Health Effects of Nitrates in Water.

Illinois Institute for Environmental Quality, Chicago, January 1974. 45p. (Available through National Technical Information Service (NTIS) as PB-229 500).

Key Words: nitrates, combined municipal and storm systems, surface water (fresh), drinking and recreational water.

Abstract:
Contamination of surface waters with nitrates may result from municipal or industrial (petroleum refineries, food processing plants) wastewater effluents, from surface runoff, from direct rainfall, from interflow (percolating water intercepted by drainage systems before it has a chance to reach the ground water table), from feedlot and plant residues, and from soils and commercial fertilizers. It has been pointed out that nitrogen usage in the U.S. increased from 378,543 tons of N in 1940 to 6,912,706 tons in 1969. Furthermore, fertilizer use, especially nitrogen, has increased more rapidly in Illinois than in the nation as a whole. In 1940, Illinois consumed 0.5% of the N used in the U.S., but by 1969, this amount increased to 9.1%.

Nitrogenous wastes from barnyards, feedlots, or septic tank disposal fields may seep through the soil and enter the ground water which feeds wells. Water percolating through decomposing peat soils or through mineral soils which have received a heavy application of nitrogen fertilizer or manure may also contaminate ground water supplies.

Agnew, R. W., C. A. Hansen, O. F. Nelson, W. H. Richardson and L. Holt.

A Biological Adsorption System for the Treatment of Combined Sewer Overflow.

Presented at the 46th Water Pollution Control Federation Annual Conference, Cleveland, Ohio , October 2, 1973.

Key Words: suspended solids, ammonia, BOD, nitrates, phosphates, total organic carbon, combined municipal and/or stormwater systems .

Abstract:

A 20 mgd modified contact stabilization process has been designed, constructed, and operated for a two year period for the treatment of potential combined sewer overflows at Kenosha, Wisconsin. The system shows significant promise as a technique for treating combined sewage.

Evaluation of the system during 46 separate events shows that the process is capable of producing an effluent well within the EPA guidelines for secondary wastewater treatment plants. In addition, it provides standby capacity should the dry weather plant be disabled. Multiple use of the demonstration system equipment during dry weather has enabled a 15% and 37% reduction in BOD_5 and suspended solids from the dry weather plant.

Because of the central location of the facility, it can be operated and maintained by sewage treatment plant personnel. The operation and maintenance costs for the system are approximately equivalent to O&M costs for conventional secondary wastewater treatment plants.

Akin, E. W., W. H. Benton, and W. F. Hill, Jr.

Enteric Viruses in Ground and Surface Waters: A Review of Their Occurrence and Survival.

In: Proceedings of the Thirteenth Water Quality Conference; Virus and Water Quality: Occurrence and Control. University of Illinois, February 1971. pp. 59-74.

Key Words: coxsackie virus, polio virus, ECHO virus, direct contact, surface water (fresh), surface water (marine), groundwater.

Abstract:

Enteric viruses have been isolated from surface water samples collected throughout the world. Investigations reviewed in this paper indicate that enteric viruses were isolated from an average of 36 percent of the surface water samples examined. These viruses are shed in the feces of infected men and animals and may enter water systems by way of soil runoff and sewage, both treated and untreated. The increased frequency of water reuse for domestic purposes has increased the probability of human contact with contaminated surface waters.

Laboratory studies indicate that viruses tend to adsorb to soil particles and would therefore be removed before they reach groundwater or soon after entering the underground system. However, epidemiological studies have implicated both contaminated surface and groundwater as the transmission routes in a limited number of infectious hepatitis outbreaks. Remarkably, no widespread waterborne epidemics of viral disease other than infectious hepatitis have been substantiated. The amount of endemic disease caused by contact with virus-contaminated surface waters is completely unknown. The transmission route of endemic viral disease is difficult to determine due to the large percentage of asymptomatic infections which occur with these viruses.

Numerous workers have studied the survival of enteric viruses in waters and have found them to survive for a significant length of time to consider water a potential route of viral disease transmission. They have shown that 2 to 100 days are required for various members of the enteric virus family to lose 99.9 percent of their initial infectivity when suspended in different surface waters at 20°C to 25°C.

The flow-through experimental system has allowed study of virus survival in estuarine water under quasi-natural conditions. In these experiments, polio virus 1 infectivity was reduced by 99 percent in 4 hours at 30°C (summer conditions) and 5 to 15 hours at 22°C (autumn conditions). By yielding survival data indicative of that occurring in the natural setting, field studies of this type may have a very practical application. With this information and viral isolation data, water treatment requirements and recycling-frequency guidelines may be realistically determined.

Alberts, J.J., J.E. Schindler, and D.E. Nutter.

Elemental Mercury Evolution Mediated by Humic Acid.

Science. 184:895-897. May 1974.

Key Words: mercury, surface water (fresh), surface water (marine).

Abstract:

Elemental mercury is formed in aqueous solution by the chemical reduction of mercuric ion in the presence of humic acid. The reduction proceeds with first order kinetics (rate constant 0.009 hr^{-1}) and is dependent on pH. The reaction mechanism involves interaction of the ionic species with the free radical electrons of the humic acid.

Albertson, O.E. and R.J. Sherwood.

Phosphate Extraction Process.

JWPCF. 41(8):1467-1490. August 1969.

Key Words: phosphates, activated sludge, chemical treatment.

Abstract:

1. Laboratory tests were conducted on a complementary liquid and sludge handling treatment system which involved chemical removal of phosphate and a greatly increased BOD removal followed by activated sludge to reduce the balance of phosphate and BOD to the desired level. The phosphate removal system can reduce the operating costs associated with phosphate removal to a level equivalent to that required for conventional treatment considering the overall operating cost for waste treatment.

2. Both laboratory and commercial tests established the fact that combustion of lime mud with wastewater sludge is practical and that calcium oxide can be recovered from the combustion ash. The combustion of sludge must be conducted at a temperature sufficient for calcination of the calcium carbonate. The recovery of the calcium carbonate as calcium oxide can be conducted at one-half the cost of purchased lime and reduces the problem of disposing of large quantities of chemical precipitate.

3. The phosphate removal system design is similar to that of a conventional plant. Allowing for a 40 to 50 percent reduction in the aeration tank volume, it is possible that the plant can be built for a cost comparable to a conventional activated sludge plant employing incineration for disposal of the waste sludge.

4. Higher removal efficiency of phosphate combined with ammonia nitrogen removal can be achieved with the same basic approach. However, operating and capital costs will exceed conventional treatment costs.

5. Because of the high pH in the raw waste an additional benefit of the phosphate removal system will be the elimination of sulfide odors commonly found in the primary treatment portion of wastewater plants.

6. The complementary approach of phosphate removal, using the most economical combination of known phosphorus removal mechanisms, now provides the engineer with an important tool to achieve significant levels of phosphate reduction without incurring penalties of increased operating cost, capital cost, and larger land requirements.

Albone, E.S., G. Eglinton, N.C. Evans, J.M. Hunter, and M.M. Rhead.

Fate of DDT in Severn Estuary Sediments.

Environmental Science and Technology. 6(10):914-919. October 1972.

Key Words: pesticides, DDT, surface water (fresh), anaerobic digestion.

Abstract:

The functions of estuarine sediments[as pollutant sink and as pollutant bank]are assessed in relation to the fate of DDT in the environment. p,p'-DDT was degraded more slowly when incorporated in situ in Severn estuary sediments than when incubated in sediment samples maintained under hydrogen in the laboratory. These transformations are compared with the more extensive degradation of DDT on incubation in anaerobic sewage sludge. In all incubations, metabolites included p,p'-DDT. The wider application of the techniques developed is discussed.

Albone, E.S., G. Eglinton, N.C. Evans, and M.M. Rhead.

Formation of bis (p-Chlorophenyl)-acetonitrile (p,p'-DDCN) from p,p'-DDT in Anaerobic Sewage Sludge.

Nature. 240:420-421. December 1972.

Key Words: pesticides, DDT, anaerobic digestion.

Abstract:

This paper discusses degradation of DDT in the anaerobic sludge digestion process.

Albrecht, A.E.

Disposal of Alum Sludges.

JAWWA. 64(1):46-52. January 1972.

Key Words: COD, aluminum, gravity thickeners, drying beds.

Abstract:

This article examines alternate means for disposing of sewage sludge.

Alexander, M.

Microbial Degradation of DDT.

Cornell University, Ithaca, New York, Department of Agronomy, July 1974. 35p. (Available from National Technical Information Service (NTIS) as AD/A 781-903).

Key Words: DDT, bacteria, surface water (fresh), surface water (marine), crops.

Abstract:

One-half of the marine bacteria tested converted DDT to water-soluble products. Mucor alternans converted DDT to water-soluble metabolites at a rate four times greater than the most active marine bacterium. Techniques were developed to isolate and purify these metabolites. The relationship of chemical structure to biodegradability of DDT analogs was investigated. Para substitution of one of the two aromatic rings with chloro, nitro, hydroxyl, or amino groups significantly reduced the rate of biodegradability. The most resistant compounds were those with both rings containing these substituents. Various environmental factors were examined for their effect on DDT metabolism in marine waters.

Alivisatos, G.P. and J.A. Papadalsis.

MacConkey and Glutamate Media in the Bacteriological Examination of Seawater.

Journal of Applied Bacteriology. 39:287-293. 1975.

Key Words: coliforms, bacteria, surface water (marine).

Abstract:

Confirmatory tests were made in 4807 positive tubes of MacConkey broth. It was found that when an equal volume of seawater was added to a double strength MacConkey broth only 88% of the tubes contained coliform organisms (12% false-positive reactions); when, however, the ratio of the volume of seawater to broth was 1/5 or less, coliform organisms were found in 93.5% of the positive tubes (6.5% false-positive reactions). Glutamate medium gives a higher rate of false reactions than MacConkey broth when an equal volume of seawater is added to double strength medium. When the volume ratio of seawater to glutamate medium is equal to or less than 1/5, then the minerals-modified lactose glutamate medium gives better results than MacConkey broth in the coliform and especially in the Escherichia coli count. The difference is statistically significant.

It is thus concluded that for the bacteriological examination of seawater the volume ratio of water to medium should be 1/5 or less and also that glutamate medium is the medium of choice.

Allen, G.M. and L. Dennis.

Report on Pilot Aquaculture System Using Domestic Wastewaters for Rearing Pacific Salmon Smolts.

In: Wastewater Use in the Production of Food and Fiber--Proceedings. EPA-660/2-74-041, U.S. Environmental Protection Agency, Washington D.C., Office of Research and Development, June 1974. pp. 162-198.

Key Words: chromium, copper, iron, nickel, zinc, chemical treatment, fish, air.

Abstract:

Coho fingerling and chinook fry can be successfully reared in advanced secondarily treated domestic wastewaters mixed with saltwater. The best results in our studies were in mixtures producing 10-15 percent salinity (roughly two parts effluent to one part saltwater).

Experiments with coho fingerling reared in late fall to winter have not carried these salmon to complete smolting because of the need to have the ponds ready for chinook salmon experiments, the primary target species. Results of these rearing experiments suggest the management possibility of enhancing estuarine survival through such an intermediate period of brackish-water rearing. With completion of a recirculation aquarium system next to our ponds for fish holding and marking, we will begin to test this hypothesis by marking all coho salmon reared, and by holding them for release under the most favorable conditions possible.

Reliable aeration systems are essential in wastewater mariculture because of the rapidity of oxygen depletion which can occur under certain environmental conditions (heavy fog or cloud cover in particular). Forced-air aeration appears most favorable, and probably will improve pond conditions by stripping ammonia produced by salmon metabolism.

Allen, M.J. and S.M. Morrison.

Bacterial Movement through Fractured Bedrock.

Ground Water. 11(2):6-10. March /April 1973.

Key Words: bacteria, air, direct contact, groundwater, ponding/land application, land reclamation.

Abstract:

The movement of bacteria-laden waters percolating through fractured crystalline bedrock in mountainous terrain was examined to determine whether effluent originating from domestic waste disposal systems could contaminate shallow groundwater supplies. Inoculated waters were injected into holes and/or wells at two geologically different test sites (granitic, metamorphic) to evaluate the extent of microbial filtration in or along bedrock fractures. Microbiological examination of tracer waters, sampled both above and below the zone of saturation, was made.

Field studies showed that the direction and rate of movement of contaminated ground waters were controlled largely by the anisotropic nature of the geologic stratum, vertically by the orientation of major bedrock fracture sets. Inoculated waters were found to be readily transported by the groundwater gradient into a downslope well. At one test site, a tracer bacterium traversed a horizontal distance of 94 feet in 24-30 hours. Continued bacteriological analysis of the contaminated well found the organism to be present for at least five days after inoculation of the upslope well.

In the zone of aeration, bacteria-laden effluent was found to percolate in or along fractures with inadequate filtration prior to entering the groundwater. Studies conducted in metamorphic rock demonstrated that while fecal-type bacteria decreased slightly during percolation through bedrock fractures, total bacterial densities were generally unchanged.

From the hydrogeological and microbiological data obtained at both test sites, it can be concluded that moderate percolation rates and minimum distances between water wells and leachfield type waste disposal units are inadequate to protect potable groundwater supplies from contamination in mountainous terrain.

Al-Shahristani, H. and K.M. Shihab.

Variation of Biological Half-Life of Methylmercury in Man.

Archives of Environmental Health. 28:342-344. June 1974.

Key Words: epidemiology, mercury.

Abstract:

The variation of biological half-life (BHL) of methylmercury in 48 patients who had ingested treated grains is studied. The BHL was calculated from the distribution of mercury concentration along the head hair. Instrumental neutron activation analysis was used for mercury determination.

The BHL of methylmercury varied from 35-189 days with an average of 72 days. The widespread BHLs indicated that some persons may face a much higher risk than others with the same body burden.

This abnormality was not related to age or diet.

Ames, B.N.

Carcinogens Are Mutagens: A Simple System for Detection.

Presented at the American Cancer Society Seminar for Science Writers, March 26-30, 1976.

Key Words: epidemiology, salmonella.

Abstract:

About 300 carcinogens and noncarcinogens of a wide variety of chemical types have been tested for mutagenicity in the simple salmonella/microsome test. The test uses bacteria as sensitive indicators of DNA damage, and mammalian liver extracts for metabolic conversion of carcinogens to their active mutagenic forms. There is a high correlation between carcinogenicity and mutagenicity: 90% (157/175) of the carcinogens were mutagenic in the test including almost all of the known human carcinogens that were tested. Damage to DNA by environmental chemicals and radiation is likely to initiate most human cancer and genetic defects. The salmonella test can play a central role in a program of prevention: to identify mutagenic chemicals in the environment (all indications are there are many) and to aid in the development of non-mutagenic products to further human exposure.

Ames, B.N., J. McCann, and E. Yamasaki.

Methods for Detecting Carcinogens with Salmonella/Mammalian-Microsome Mutagenicity Test.

Mutation Research. 31:347-364. 1975.

Key Word: epidemiology.

Abstract:

This is a review article on the Ames Test applications for detecting carcinogens and mutagens.

Ames, L.L., Jr. and R.B. Dean.

Phosphorus Removal from Effluents in Alumina Columns.

JWPCF. 42(5):R161-R172. May 1970.

Key Words: phosphates, adsorption/ion exchange.

Abstract:

The effects of various compositional changes on phosphorus removal by alumina columns from a synthetic secondary wastewater effluent were studied.

1. The concentration of Mg^{+2} and Ca^{+2} showed marked effects on alumina column phosphorus capacity, with the phosphorus capacity about half for the solution containing no Ca^{+2} or Mg^{+2} as compared to solutions containing Ca^{+2} and Mg^{+2}. Adsorption onto the alumina occurs partly as a calcium- or magnesium-phosphorus complex, rather than as a simple phosphorus anion.

2. Increasing the competing sulfate concentration in the influent solution to 4,800 mg SO_4^{-2}/l showed little effect on phosphorus adsorption by alumina.

3. Raising the pH of the synthetic wastewater effluent to greater than 8.0 led to precipitation of calcium carbonate on the alumina grains, which progressively lowered alumina phosphorus capacity. This problem was not encountered when actual wastewater effluent was used.

4. Alumina columns could be regenerated satisfactorily with NaOH alone in about 1 hr. An acidic wash was not required. Alumina dissolution in a 1 M NaOH eluting solution averaged 0.33 wt percent/hr.

Amirhor, P. and R.S. Engelbrecht.

Virus Removal by Polyelectrolyte-Aided Filtration.

JAWWA. 67(4):187-192. April 1975.

Key Words: viruses, filtration.

Abstract:

This article details the potential use of uncoated and polyelectrolyte-aided diatomaceous-earth filtration with respect to the removal of bacterial virus MS2 from water and wastewater effluent. The effects of certain operational parameters in removing virus by polyelectrolyte-aided diatomaceous-earth filtration are evaluated.

Amramy, A.

Waste Treatment for Ground Water Recharge.

Advances in Water Pollution Research. 1964(2):
147-168.

Key Words: total dissolved solids, ammonia, BOD, COD, chlorides, nitrates, nitrites, iron, manganese, ponding/land application, groundwater.

Abstract:

On the basis of the research carried out to date, to be supplemented by further studies now under way, it has been concluded that, for Tel Aviv conditions, it is not necessary to subject the waste water to conventional methods of biological treatment in order to produce an effluent suitable for ground water recharge by spreading. Instead, the relatively cheaper method of sewage treatment by lagoons, at much heavier loadings than currently used as design bases in the U.S.A., is sufficient for the purpose.

An effluent from sewage stabilization lagoons, containing suspended organic matter largely in the form of live algae, can be applied to dune-sand overlying suitable subsoil layers, without the danger of clogging and without marked diminution of the infiltration rate. The recharged water subsequently recovered from properly spaced wells can attain potable quality, provided the spreading basins are operated intermittently, i.e. in alternating wetting and resting periods. This conclusion is believed to be of particular importance to developing countries where the need for sewage reclamation exists, but the introduction of projects to this effect is hampered by severe limitations on available capital and by the lack of skilled personnel necessary for the operation of the 'mechanical' processes of waste treatment.

Andelman, J.B.

The Effect of Water Treatment and Distribution on Trace Element Concentrations.

In: Chemistry of Water Supply Treatment and Distribution. A.J. Rubin, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1975. pp. 423-440.

Key Words: chlorination, drinking and recreational water, barium, boron, aluminum, copper, iron, maganese, molybdenum, zinc.

Abstract:

There is some epidemiological evidence relating the trace element content of municipal water supplies to chronic disease, especially cardiovascular diseases. At this point the evidence is quite inconclusive and the possible mechanisms are generally uncertain. Acute illness from exposure to high concentrations of these trace elements in the United States is negligible. However, a survey of community water supplies has shown that for all those trace elements for which there are mandatory U.S. Public Health Service standards, only silver was not found in distribution system samples above the maximum permissible concentrations.

In order to properly assess the concentration levels of trace elements in municipal waters at the point of human consumption, it is necessary to consider geographic and time variabilities, as well as changes with treatment and distribution. Large variations in the concentration of many trace elements have been observed in different regions for surface waters of the United States, as well as on a microgeographic scale, even for different water sources serving the same municipality. In addition, the time variabilities at a given water intake have been found to be considerable.

Water treatment can have a significant effect on trace element content. Although for many elements concentrations are reduced in treatment, in some cases increases occur. It has also been shown that chemical state and physical form will influence the extent of removal, as will adjusting variables in the treatment operation. Considerably more investigation is required in the latter area.

Finally, the distribution process itself can affect the concentration of trace elements, with both increases and decreases having been observed. All these variabilities and changes emphasize the need for a carefully designed sampling scheme in attempting to assess the levels of concentrations of trace elements to which humans are exposed through their drinking water. In particular, the need to sample at the terminals of the distribution system, rather than at the treatment plant, is especially important.

Andelman, J.B.

Incidence, Variability and Controlling Factors for Trace Elements in Natural, Fresh Waters.

In: Trace Metals and Metals-Organic Interactions in Natural Waters. P.C. Singer, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1975. pp. 423-440.

Key Words: aluminum, barium, boron, copper, iron, manganese, nickel, surface water (fresh), surface water (marine).

Abstract:

The variability of concentrations of trace elements in natural fresh waters is great, both on a macro and micro geographic scale, as well as with time at a given location. In most instances, it is difficult to correlate their concentrations with such characteristics as stream flow or lithologic environment.

In order to accurately characterize trace elements and attempt to develop models for predicting their behavior and cycling through water and associated environments, it is necessary to distinguish their various chemical and physical states, such as particle size and incidence and forms of complexes and chelates. Such speciation probably plays an important role in their movement in water, as well as their availability to and uptake by aquatic animals and plants. There is some evidence that such biological interactions influence the concentration levels of these trace elements, as well as their transport in natural waters.

There are a variety of sources that contribute trace elements to natural fresh waters, including fallout and precipitation from air, human activities, and flow of water over soils and minerals. In some cases specific contributions from these sources can be identified. However, the status of knowledge in this regard in general is quite primitive, and adequate models for the movement of trace elements into and through these waters have yet to be developed.

Andelman, J.B. and M.J. Suess.

Polynuclear Aromatic Hydrocarbons in the Water Environment.

Bulletin of the World Health Organization. 43:479-508. 1970.

Key Word: epidemiology.

Abstract:

Many polynuclear aromatic hydrocarbons (PAH) are known to be carcinogenic to animals and probably to man. This review is concerned with carcinogenic and non-carcinogenic PAH in the water environment, with emphasis on 3,4-benzpyrene (BP) because it is ubiquitous, is one of the most potent of the carcinogenic PAH, and has been widely studied. Although PAH are formed in combustion and other high-temperature processes, there is also evidence for their endogenous formation in plants, which may explain their ubiquity therein. Although the solubility of these compounds in pure water is very low, they may be solubilized by such materials as detergents, or they may otherwise occur in aqueous solution associated with or adsorbed on to a variety of colloidal materials or biota, and thereby be transported through the water environment. A notable characteristic of PAH is their sensitivity to light.

PAH have been found in industrial and municipal waste effluents, and occur in soils, ground waters and surface waters, and their sediments and biota. With the exception of filtration or sorption by activated carbon, conventional water treatment processes do not efficiently remove them, and they have been found in domestic water supplies. Because of the ubiquity of PAH in the environment, it is impossible to prevent completely man's exposure to them; nevertheless their surveillance should be continued and their concentrations in the environment should be reduced where practicable.

Andre, D.A., H.H. Weiser, and G.W. Malaney.

Survival of Bacterial Enteric Pathogens in Farm Pond Water.

JAWWA. 59(4):503-507. April 1967.

Key Words: salmonella, shigella, trickling filters.

Abstract:

The longevity of representative species of bacterial enteric pathogens exposed to water from Ohio farm ponds was studied. Salmonella species survived about 16 days, while shigella species survived about 12 days, indicating survival of enteric pathogens in pond water for a significant time interval. These observations emphasize the importance of preventive measures to block entrance of such organisms into pond waters, including such precautions as location of the pond in a spot that will avoid polluting drainage and exclusion of farm animals from the pond watershed. The results also emphasize the importance of an effective water treatment system that is properly maintained.

Andren, A.W. and D.H. Klein.

Selenium in Coal-Fired Steam Plant Emissions.

Environmental Science and Technology. 9(9):856-858. September 1975.

Key Words: selenium, agriculture, groundwater, crops.

Abstract:

The study states that Se in the range of from 0.04-2μ g/g is required in the diet of animals to prevent deficiency. At slightly higher levels (4 or 5μ g/g), however, toxicity results. Selenium is a protective agent against toxic effects of cadmium and mercury.

Selenium has not been shown to be an essential element to plant growth, although several investigators have shown that different plants concentrate Se in nature in varying amounts. Results of a review of the variability in Se uptake by plants by two different groups of researchers indicate that the physical and chemical form of Se in soils determines its availability to plants and subsequently to animals. Factors that control the forms of Se are soil pH, redox potentials, microbial activity, and soil mineralogy. In acid soils any SeO_3^{2-} is sorbed onto ferric oxides and made unavailable for further oxidation. In alkaline soils, Se may be oxidized to SeO_4^{2-}, which is readily available for plant uptake. Researchers reported that 65% of the forage crops in the industrial eastern U.S. (acidic soils) contain insufficient Se for the growth of healthy animals and subsequently it has been suggested that the Se derived from fossil fuel combustion might be desirable for the eastern U.S. Results from this study, however, indicate that Se is emitted as Se^0, which is unavailable for plant uptake. In areas of alkaline soils, such as parts of the arid western U.S., Se may be oxidized to SeO_4^{2-}. The potential for toxic or beneficial effects in such areas must be considered.

Andrews, W.H. and M.W. Presnell.

Rapid Recovery of *Escherichia coli* from Estuarine Water.

Applied Microbiology. *23*(3):521-523. March 1972.

Key Words: *Escherichia coli*, epidemiology.

Abstract:
The efficiencies of two 24-hr elevated-temperature tests to recover *Escherichia coli* from estaurine water were compared simultaneously with the 72-hr standard methods procedure of the American Public Health Association (APHA). From 1,710 tubes, *E. coli* was recovered 222 times in lauryl tryptose medium incubated at 44 ± 0.2C for 24 hr, 261 times in an experimental medium incubated at 44.5 ± 0.2C for 24 hr, and 257 times by the 72-hr APHA method. The number of false positives enumerated was similar in all three tests. The data indicated that *E. coli* in raw seawater could be determined in 24 hr without a significant less of accuracy.

Antonie, R.L., D.L. Kluge, and J.H. Mulke.

Evaluation of a Rotating Disk Wastewater Treatment Plant.

JWPCF. 46(3):499-511. March 1974.

Key Words: rotating biological discs, BOD, suspended solids.

Abstract:

A 0.5 mgd (1.9-mil l/day) rotating disk municipal wastewater treatment plant has undergone 9 months of a 12 month evaluation period. In that time, it has demonstrated the capability of achieving high degrees of BOD and SS removal and nitrification. It has exhibited stable operation under conditions of fluctuating hydraulic and organic loading and wastewater temperature. The high density of the sludge solids generated by the process indicates signigicant potential savings in overall treatment plant construction and operating costs. These factors, along with the low power consumption and low maintenance requirements, make the process attractive for application to a variety of wastewater treatment problems and a wide range of treatment plant sizes.

Antonie, R.L.

Evaluation of a Rotating Disk Wastewater Treatment Plant.

JWPCF. 46(12):2792-2795. December 1974.

Key Words: rotating biological discs, BOD, suspended solids.

Abstract:

This paper is a response by the manufacturer of rotating disks to deficiencies in the system. From the author's correspondence, he indicates that the system can be adapted to a wide variety of applications as can activated sludge.

Antonucci, D.C. and F.D. Schaumburg.

Environmental Effects of Advanced Wastewater Treatment at South Lake Tahoe.

JWPCF. 47(11):2694-2701. November 1975.

Key Word: epidemiology.

Abstract:

This is an excellent article on the South Lake Tahoe Treatment Plant including discussions of treatment effectiveness, energy consumption, general descriptions of the treatment procedures and support industries, as well as a flow sheet of the plant.

Aoki, T., S. Eguso, T. Kimsura, and T. Watanabe.

Detection of R Factors in Naturally Occuring *Aeromonas Salmonicida* Strains.

Applied Microbiology. 22(4):716-717. October 1971.

Key Words: epidemiology.

Abstract:

R factors were detected in *Aeromonas salmonicida* strains isolated from diseased salmonid fish. One of such R^+ strains was the one isolated in the United States as early as 1959.

Applequist, M.D., A. Katz, and K.K. Turekian.

Distribution of Mercury in the Sediments of New Haven (Conn.) Harbor.

Environmental Science and Technology. 6(13):1123-1124. December 1972.

Key Words: mercury, surface water (fresh).

Abstract:

Distribution of mercury in sediments of New Haven Harbor indicate that the primary supply is from municipal sewer outfalls in the harbor.

Argo, D.G. and G.L. Culp.

Heavy Metals Removal in Wastewater Treatment Processes.
Part I.

Water and Sewage Works. 119(8):62-65. August 1972.

Key Words: filtration, chemical treatment, adsorption/ ion exchange, cadmium, chromium, copper, iron, manganese, nickel, selenium, zinc, silver.

Abstract:

This paper gives a review of heavy metal removal by various processes. The removal of heavy metals during primary and secondary treatment can proceed by two mechanisms:

1. Precipitation of metal hydroxides

2. Sorption of soluble trace metals by the sludges.

The precipitation of heavy metals is defined by the solubility product.

$$\frac{[M_x^{++}]\ [(OH^-)^2]}{[M_x(OH)_2]} = V_{sp}$$

Argo, D.G. and G.L. Culp.

Heavy Metals Removal in Wastewater Treatment Processes.
Part 2 - Pilot Plant Operation.

Water and Sewage Works. 119(9):128-133. September 1972.

Key Words: cadmium, chromium, copper, lead, mercury, selenium, zinc, antimony, arsenic, berillium, BOD, COD, suspended solids, total dissolved solids, phosphates, filtration, chemical treatment, adsorption/ion exchange, influent characteristics, effluent characteristics.

Abstract:

The Orange County Water District's pilot plant treatment system of lime coagulation and settling, mixed media filtration, and activated carbon adsorption was very effective in reducing the concentrations of cadmium, hexavalent chromium, zinc, and copper. This advanced wastewater treatment scheme also reduced the concentrations of the remaining heavy metals studied with varying degrees of success. It was observed that removal efficiency appeared to be dependent on influent concentration. The lower removals always occurred when influent concentrations were very low.

The results of this investigation indicate that certain heavy metals can be removed along with organics, suspended solids, and other inorganics by lime coagulation, mixed media filtration, and activated carbon adsorption. Further research is needed to more fully define the mechanism of these removals. The advanced wastewater treatment process selected for the Orange County Water District's wastewater reclamation plant could effectively reduce potentially hazardous concentrations of heavy metals and produce an effluent compatible with water quality discharge standards imposed by the regulatory agencies.

Armstrong, F.A.J. and A.L. Hamilton.

Pathways of Mercury in a Polluted Northwestern Ontario Lake.

In: Trace Metals and Metal-Organic Interactions in Natural Waters. P.C. Singer, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1974. pp. 131-156.

Key Words: mercury, surface water (fresh).

Abstract:

The total quantity of mercury in sediments in the lake is somewhat more than 2,000 kg, or about 20 percent of our estimate of the total amount discharged during the first eight years of operation of the chlorine-alkali plant in Dryden. Deposition of mercury has been greatest at the eastern end of the lake, although the water is shallower and has more rapid circulation than in the central basin. Deposition of mercury has also occurred in the arms of the lake.

It seems that even with the present controls, there is little hope of any rapid improvement in the degree of pollution of the sediments. For any improvement it is of course necessary that existing deposits should be covered by material of low mercury content. Several centimeters of depth may be required because of disturbance by animals, and such an accumulation might take some centuries if our estimates of the sedimentation rate in the lake are correct. Moreover, improvement is dependent on the newly deposited material having a low mercury content so that it is itself harmless, and this can hardly be said to be the case when the material being deposited in Clay Lake at present has a mercury content of more than 2 ug/g.

Arpa, S.S.

Nitrogen Removal Obtained through Heterotrophic Growth in Trickling Filters.

U.S. Department of the Interior, Washington, D.C., Office of Water Research and Technology, August 1974. 57p. (Available from National Technical Information Service (NTIS) as PB-239 925).

Key Words: ammonia, trickling filters.

Abstract:

Conventional biological treatment facilities are efficient in removing carbonaceous materials, but most remove only a small fraction of the biochemical oxygen demand exerted by nitrogen. This study investigated the use of plastic media trickling filters and the growth kinetics of the heterotrophic bacteria on the filters for more complete treatments. Mixed substrate environments were examined with the help of a mathematical model. Laboratory results are summarized on removal rates for glucose and ammonia-nitrogen under various conditions. Kinetic constants are tabulated.

Assessing Potential Ocean Pollutants.

National Research Council, Washington D.C., Commission on Natural Resources, Ocean Affairs Board, 1975. 438p.

Key Words: pesticides, synthetic/organics, antibiotics, elemental contaminants.

Abstract:
Six groups of materials were studied: transuranic elements, synthetic organic chemicals, ocean discharge, metallic wastes, medicinal wastes, and marine litter. A method for reviewing technologies with a potential impact on marine systems was developed and tested and an effort was made to determine whether the technologies clearly pose a potential hazard, whether they are clearly unimportant or whether they fall into an intermediate category and need further study. Among conclusions reached were:

- Release of transuranic elements to the marine environment should be kept an absolute minimum.
- Increased use of low molecular weight-chlorinated hydrocarbons will result in increased levels of these compounds in the environment.
- Wastes should not be discharged into biologically active areas.

Atkins, P.F., Jr., D.A. Scherger, R.A. Barnes, and F.L. Evans III.

Ammonia Removal by Physical-Chemical Treatment.

JWPCF. 45(11):2372-2388. November 1973.

Key Words: ammonia, filtration, chlorination.

Abstract:

1. Ammonia-nitrogen can be removed to any desired level by the chlorination-dechlorination system.

2. Complete removal of ammonia-nitrogen from the wastewater would require a chlorine:ammonia-nitrogen feed rate of approximately 9:1.

3. The chlorination-dechlorination system can remove free chlorine and all forms of chloramines applied to the system.

4. There is an initial ammonia-nitrogen breakthrough during startup of the dechlorination process that stops after a brief lag or acclimation period.

5. The ammonia removal process tends to depress the pH in nonbuffered systems and might necessitate pH adjustments in the final effluent.

6. The chloride content of the wastewater was increased, on the average, from 193 mg/l to 293 mg/l when the ammonia-nitrogen removal process was used.

7. Bacterial reductions in the ammonia-nitrogen removal process exceeded the normal effluent requirements as set forth by the state of Michigan The chlorination-dechlorination process also provided a dechlorinated effluent.

8. The dissolved oxygen level of the final effluent varied between 1 and 2 mg/l. Reaeration facilities would have to be provided if greater dissolved oxygen levels were required.

9. The carbon dosage required in the organic removal stage is approximately 500 lb/mil gal (60 kg/mil l) of wastewater treated.

10. Low lime treatment [150 to 175 mg/l as $Ca(OH)_2$] - pH ranging between 8.8 and 9.4 - will, with proper coagulation and sedimentation, reduce the phosphorus level of the wastewater by over 80 percent.

Aubert, M., P. Koch, and J. Garancher.

The Diffusion of Bacterial Pollution in the Sea.

Advances in Water Pollution Research. 1969:793-809.

Key Words: bacteria, surface water (marine).

Abstract:

From these studies it can be deduced that the discharges of essentially domestic wastewater into a reconstituted marine environment favorably affect the growth of the planktonic biomass, even when the sewage rate is very high (20%). Furthermore, at high concentrations these discharges tend to modify slightly the biological equilibrium and to favor the efflorescence of protozoa. However, antibiotic action caused by increased planktonic forms has proved to be greater than the growth of bacteria enriched with sewage, and this finally results in their total destruction.

Thus it appears, in the light of these experiments, that the discharge of wastewater into the sea, excluding industrial wastewater, is not likely to endanger marine life; although modifications in this life are evident, they are of a relatively localized nature.

Thus, an appreciation of the laws governing bacteria diffusion opens the way to studies of already existing or projected sea outfalls. These studies, based on hydrological as well as current measurement, will take into account the sanitary requirements associated with the location of the outlets. Systematic measurements of the currents and the distribution of the masses of water, the study of the temperature-salinity relationships, and finally research on the processes of diffusion with the help of physical or biological tracers, will allow future installations of sewage discharge pipes to be selected with discernment, and the degree of treatment necessary before discharge to be predetermined. Subsequently, it is necessary to measure by direct observation the results of the discharges made, so that in the course of time adjustments may be made in the treatment requirements in accordance with future requirements.

Aubert, M., H. Lebout, and J. Aubert.

Effect of Marine Plankton in Destruction of Enteric Bacteria.

Advances in Water Pollution Research. 1964(3):308-314.

Key Words: bacteria, surface water (marine).

Abstract:

These experiments confirm the existence of antibiotic activity in a marine environment, and demonstrate that this activity depends on the bacteriostatic action of certain components of the planktonic population, particularly the phytoplankton, which were the dominant components of the plankton used in these tests.

The factor responsible for this activity is thermolabile and appears to be biochemical in nature, either a secretion or a component of the plankton. However, the possibility cannot be excluded that this factor may be due to the presence of micro-organisms, specifically or unspecifically related to the plankton. The phytoplankton seems to be of particular importance, but some zoo-planktonic forms may well be endowed with a similar power, either specifically or through the absorption of nutriments.

Aulenbach, D.B., J.J. Ferris, N.L. Clesceri, and T.J. Tofflemire.

Thirty-five Years of Use of a Natural Sand Bed for Polishing Secondary Treated Effluent.

Presented at the Rural Environmental Engineering Conference. University of Vermont, September 27, 1973.

Key Words: ammonia, BOD, nitrates, nitrites, germanium, chlorides, coliforms, viruses.

Abstract:

There is insufficient information available as to the effectiveness of discharging wastewaters, either treated or untreated, directly into the soil to make use of the characteristics of the soil which enable it to purify wastes.

The treatment system at Lake George Village offers an opportunity to study both the treatment efficiency of sandy soils and the effect of relatively long (35) years of use. Samples were secured from various locations; results are summarized.

Aulenbach, D.B., N.L. Clesceri, T.J. Tofflemire, S. Beyer, and L. Hajas.

Water Renovation Using Deep Natural Sand Beds.

JAWWA. 67(9):510-515. September 1975.

Key Words: ammonia, chlorides, nitrates, phosphates, suspended solids, groundwater, surface water (fresh), influent characteristics, effluent characteristics.

Abstract:

The Lake George Village sewage treatment plant is doing an adequate job of purifying the wastewater - providing an effluent that is safe for drinking, satisfactorily removing essentially all of the phosphorus from the wastewater, and providing a nitrified effluent that at the present time appears to have no obvious deleterious effects upon the quality of Lake George.

Axelson, O., M. Rehn, and L. Sundell.

Herbicide Exposure - Mortality and Tumor Incidence; An Epidemiological Survey of Swedish Railway Workers.

Pesticide Abstracts. 75-1886. 1975.

Key Words: epidemiology, pesticides, herbicides.

Abstract:

An epidemiological investigation was made of tumor incidence and mortality in Swedish railway workers exposed to various herbicides. A slightly dose-response related and significantly increased tumor incidence and mortality among railway workers exposed to amitrole (3-amino-1,2,4-triazole) was shown. Almost normal conditions were found in those exposed to phenoxy acids (2,4-dichlorophenoxyacetic acid, 2,4-D; and 2,4,5-trichlorophenoxyacetic acid, 2,4,5-T). Animal experiments suggest that amitrole may produce malignant tumors in several different organs, but tumors of the thyroid and liver have received the most attention. Exposure to amitrole in this study is partly related to simultaneous exposure to diuron (3-[3,4-dichlorophenyl]-1,1-dimethylurea) and monuron (3-[p-chlorophenyl]-1,1-dimethylurea), which makes the assessment of a definite correlation between tumor increase and exposure to amitrole more difficult. This point leaves the study open to criticism, but the close agreement with data from animal experiments supports the recommendation that amitrole be used with extreme caution.

Bache, C.A., J.W. Serum, W.D. Youngs, and D.J. Lisk.

Polychlorinated Biphenyl Residues: Accumulation in Cayuga Lake Trout with Age.

Science. 177:1191-1192. September 1972.

Key Words: pesticides, chlorinated hydrocarbons.

Abstract:

The concentration of polychlorinated biphenyls was shown to progressively increase with maturity in a series of lake trout. The presence of these compounds was determined by column chromatographic isolation, specific detector gas chromatography, and mass spectrometry. The relation between fish age and the concentration of polychlorinated biphenyls was highly significant.

Baer, G.T., Jr.

Wastewater Skimmings Handling and Incineration.

Presented at the Annual Conference of the Water Pollution Control Federation, October 1975.

Key Words: suspended solids, incineration.

Abstract:

The problems encountered in skimmings handling and incineration were due to our dewatering floatable matter in the same way as settleable matter. Having separated skimmings from sludge handling, the great majority of difficulties have been overcome and efficiencies improved. These specific evaluations can now be made. The skimmings accumulated and incinerated are approximately 19 lbs. dry wt. per MG of wastewater flow. The sludge incinerator design capacity of 1,100 lbs. per hr. dry solids is now 450 lbs. per hr. skimmings with 200 lbs. per hr. sludge solids during the skimmings procedures. Also, consumption of Auxiliary fuel oil is 30 gallons per hour when applying the normal 2,500 SCFM of fluidizing air.

The incinerator capacity limits with skimmings are approached by (a) minimum oxygen level of 2.0% due to high fuel and/or dewatered sludge feed, of (b) low bed temperature of 1,240^{0} F due to insufficient dewatering, or (c) delayed oxidation due to over-feed which can be seen as a high freeboard temperature of 1,600^{0} F. These limits are identical in all respects to those of sludge incineration.

Other than the cold weather congealing, two difficulties are now encountered. One is an infrequent blockage of the centrate line which is used to return scum well subnatant to sludge thickening. This is cleared by applying plant effluent water pressure at 80 psi and has occurred 4 times per year. The second is blockage at the incinerator bed feed points which requires manual rodding to clear. This has occurred 9 times per year and did occur before the procedure changes.

The equipment supplier, Dorr-Oliver; the Consulting Engineers, Havens and Emerson; and the Authority Commission encouraged the procedural and process changes. The plant staff has adopted the new procedures to the end that it is a standard operating procedure today.

Baffa, J.J.

Artificial Groundwater Recharge and Wastewater Reclamation.

JAWWA. 69(9):471-476. September 1975.

Key Words: ammonia, nitrates, nitrites, BOD, COD, suspended solids, effluent characteristics.

Abstract:

The results of observations, made intermittently over a three-year period of pilot-plant work, indicated that water-quality parameters could be separated into two basic categories:

1. Those of a soluble stable mineral character such as chlorides and alkalinity.

2. Those having latent biological propensities such as nitrogen compounds, sulfates, phosphates, carbon dioxide, and organic solids.

Those in the latter group are capable of furnishing food or nutrient for nitrogen bacteria and sulfur bacteria and coliform organisms.

The concentrations measured were found to be affected by the amount of water recharged, the amount of natural ground-water flow affording dilution, the changes in permeability of the aquifer brought about by clogging effects and the biochemical effects of bacterial action.

The concentration of constituents in the ground water as measured at the observation wells were studied with respect to distance from the injection well and with respect to variance during injection and during resting of the injection well.

The removal of as much organic matter as possible will limit adsorption of organic materials on sand grains and thereby reduce soil clogging as well as prevent release of additional nitrogenous compounds caused by deamineation resulting from bacterial action. The removal of nitrogen and other nutrients furnishing energy to autotrophic bacteria is important from the standpoint of public health since continued recycling would result in buildup of nitrogen compound concentrations.

These requirements can be fulfilled by use of known methods of advanced water treatment and in part by the use of aerobic soil zone above the water table through recharge

basins or in part by furnishing nutrients for crop irrigation. Where the soil mantle above the water table is used for treatment purposes, attention should be focused on anion and cation exchange capabilities of the soil and the teaching of soil salts.

Baffa, J.J. and N.J. Bartilucci.

Wastewater Reclamation by Groundwater Recharge on Long Island.

JWPCF. 39(3):431-445. March 1967.

Key Words: ammonia, chlorides, nitrates, phosphates, total dissolved solids, air, direct contact.

Abstract:

This paper explains mechanisms of groundwater recharge but does not attack the problems of contaminant transmission.

Bahls, L.L.

Diatom Community Response to Primary Wastewater Effluent.

JWPCF. 45(1):134-144. January 1973.

Key Words: ammonia, chlorides, fluorides, phosphates, air, surface water (fresh).

Abstract:

Composite diatom collections and water chemistry samples were taken monthly from six stations on the East Gallatin River, (Mont.), one above and five below the effluent from the former Bozeman treatment plant.

Orthophosphate, ammonia, chloride, and fluoride below the effluent all increased significantly and eventually returned to pre-effluent levels except for orthophosphate, which remained three times more concentrated at the farthest downstream station than above the effluent.

The two dominant diatom taxa were *Nitzschia dissipata* and *N. epiphytica*, together comprising nearly 50 percent of the mean abundance of all taxa in the river. *N. dissipata* ranked first at all stations except just below the effluent where *N. epiphytica*, a nitrogen heterotroph, ranked first. These and several other taxa correlated significantly with orthophosphate, ammonia, or nitrate concentrations.

On the basis of diatom pollution indicators, diversity index values, and previous chemical studies, the maximum impact of the effluent on the diatom community was not felt until 5.3 km below the outfall. The stations with the most dissimilar flora, however, were those immediately above and below the effluent.

Diatom diversity below the effluent first rose and then fell slightly, finally reaching maximum values at the two downstream stations. Diversity was negatively correlated with ammonia and positively correlated with phosphate.

Baier, D.C.

Dry and Irrigated Pasture Field Tests Physical and Chemical Effects.

East Bay Municipal Utility District, Special District One, San Francisco, 1974. 58p.

Key Words: chlorides, nitrates, nitrites, phosphates, total dissolved solids, cadmium, copper, nickel, zinc, agriculture, crops.

Abstract:

The findings are based on one-time application of three rates of sludge to irrigated pasture plots and similar treatment to dryland pasture plots. Visual observations showed dramatic improvements in growth which agreed with the statistical results reported.

Baier, D.C.

1974 Row Crop Field Trials, Progress Report No. 3.

East Bay Municipal Utility District, Special District One,
San Francisco, 1975. 47p.

Key Words: chlorides, nitrates, nitrites, phosphates, total dissolved solids, cadmium, copper, nickel, zinc, agriculture, crops.

Abstract:

The findings are for two years (1973-1974) of field corn trials and are a combination of the findings from two applications of sludge. The results of the second year test (1974) were affected by a significant volunteer corn growth due to problems in harvesting the 1973 corn crop. The highest yielding treatment was the pasteurized sludge. All treated plots outyielded the control. Almost all of the plants showed a nitrogen deficiency. Cadmium seemed to be the most ominous of the trace elements.

Baier, D.C. and G.M. Wesner.

Reclaimed Waste Water for Groundwater Recharge.

Water Resources Bulletin. 7(5):991-1001. October 1971.

Key Words: viruses, bacteria, ammonia, BOD, air, direct contact.

Abstract:

The Orange County Water District has conducted studies in waste water reclamation and groundwater recharge since 1965. The work has been done in three phases: (1) Study in both laboratory and pilot-scale units on the feasibility of reclaiming trickling filter effluent for injection through wells into confined aquifers; (2) long-term injection study to determine the fate of injected reclaimed water and to observe the performance of a multi-casing injection well; (3) testing alternative treatment methods in a 25,000 gpd pilot plant to solve the water quality problems which developed during the injection study.

The reclaimed trickling filter effluent was found to be injectable and did not cause excessive well clogging. The multi-casing injection wells performed very satisfactorily. The reclaimed water would be acceptable for domestic use after travel through 500 feet of a confined aquifer in that bacteria, virus, and toxic material were consistently absent. However, the odor and taste which persisted in the injected reclaimed water and the high concentration of dissolved inorganics are undesirable characteristics. Methods to eliminate the odor are being tested at the present time. A cooperative project with the Office of Saline Water is under way to develop a source of desalted seawater to blend with reclaimed waste water.

Bailey, P.S.

Organic Groupings Reactive Toward Mechanisms in Aqueous Media.

In: Ozone in Water and Wastewater Treatment. F.L. Evans, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan. 1972. pp. 29-59.

Key Words: synthetic/organics, surface water (fresh), surface water (marine).

Abstract:

The intent of this brief resume of the reactions of ozone with organic compounds and of the mechanisms of these reactions has been to call attention to the great versatility and power of ozone as an oxidizing agent. In the mind of this author, it is the great hope of the future in sewage and waste treatment and water purification.

Balakrishnan, S. and W.W. Eckenfelder.

Nitrogen Removal by Modified Activated Sludge Process.

Journal of the Environmental Engineering Division, ASCE. 96(SA3):501-512. April 1970.

Key Words: ammonia, nitrates, activated sludge.

Abstract:

The nitrification studies in the activated sludge units indicate that the degree of nitrification decreased significantly with an increase in organic loading; and that complete nitrification could be obtained when the organic load factor did not exceed 0.3 to 0.4, providing all other optimum conditions are satisfied. Also, a minimum sludge age of 3 days or 4 days was found necessary for achieving nitrification at about 23°C. Complete nitrification of the final effluent from a contact stabilization process containing low carbon and high nitrogen is obtainable by feeding to an aeration tank of 8 hr aeration and a MLSS level of about 2000 mg per l. Trickling filter studies indicate that hydraulic loading has a profound effect on the degree of nitrification. There appears to be a very good correlation between the specific surface of the media and the nitrification rate constant.

Batch runs on denitrification indicate a marked increase in the rate of denitrification as the organic matter added to the MLSS increased. A good correlation (correlation coefficient, $r = 0.72$) was obtained between the removal of organics and the rate of dentrification. A fair correlation (correlation coefficient, $r = 0.5$) was found between oxygen uptake and the denitrification rate.

In conclusion, it was observed from the results of the contact-stabilization-denitrification process studies that with a completely nitrified mixed liquor containing 25 mg per l NO_3-N to 30 mg per l NO_3-N, a period of anaerobiosis of 4 hrs at about 25°C and MLSS at 2800 mg per l would bring about an average total nitrogen removal of 80% to 90%.

Balakrishnan, S., W.W. Eckenfelder, and C. Brown.

Organics Removed by a Selected Trickling Filter Media.

Water and Wastes Engineering. 6(1):A22-A25. January 1969.

Key Words: BOD, total organic carbon, coxsackie virus.

Abstract:

The studies reported here were made to evaluate the organic removal characteristics of 1-1/2 in. polypropylene flexirings. Mean residence times were determined in tracer studies using sodium chloride. Settled domestic sewage was treated in an 8-ft. pilot plant trickling filter, and the organic removal characteristics in terms of BOD and TOC were measured.

A correlation was developed between the specific surface of the media, applied BOD concentration, and the removal rate coefficient. Based on this correlation, it may be said that the flexiring media exhibits a removal rate of the same order of magnitude as other media having the same specific surface in terms of organics removal.

Balch, N., D. Ellis, J. Littlepage, E. Marles, and R. Pym.

Monitoring a Deep Marine Wastewater Outfall.

JWPCF. 48(3):429-457. March 1976.

Key Words: coliforms, ammonia, nitrates, nitrites, oil and grease, phosphates, surface water (marine).

Abstract:

This report provides a complete study of parameters (biological, chemical, and physical) resulting from deep marine discharge of untreated waste.

Bargman, R.B. and W.F. Garber.

Phosphate Removal by Activated Sludge Aeration.

Journal of the Sanitary Engineering Division, ASCE. 96(SA1):45-48. February 1970.

Key Words: phosphates, activated sludge.

Abstract:

This paper is a discussion of removal of phosphate by conventional means. During a four month period, phosphate was reduced from 29 mg/l in the primary effluent to .5 mg/l in the secondary effluent. This removal came about from the stripping of CO_2 from the mixed liquor by the increased aeration rate applied to produce nitrification. A pH of 7 in the aeration tanks was increased to 8.6 by stripping the CO_2 from the mixed liquor. This pH allowed the phosphates to precipitate in proper mole ratios, with ionic calcium, aluminum, zinc, iron, and other di- and trivalent ions.

Bargman, R.B., J.M. Betz, and W.F. Garber.

Nitrogen-Phosphate Relationships and Removals Obtained by Treatment Processes at the Hyperion Treatment Plant.

Advances in Water Pollution Research. 1970(1):14/1-17.

Key Words: aluminum, iron, zinc.

Abstract:

The most important fact to be reported is that by December 1969, the Hyperion Treatment Plant had been removing more than 95% of the soluble phosphate from a flow of about 50 mgd over a 6-month period. That is the secondary effluent phosphate as P had been decreased from about 10 mg/l to less than 0.5. Knowledge of the process gained during this period showed it to be both repeatable and controllable; and indicated that greater removals were possible if necessary or desired. We have concluded that the most important factors are substantial completion of carbonaceous oxidation with some degree of nitrification and an air rate sufficient to carry on both metabolic and carbon dioxide scrubbing operations. This method of phosphate removal is also consistent with nitrogen removal by nitrate formation and subsequent anaerobic denitrification to nitrogen gas by processes such as methanol feed for anaerobiasis to an activated carbon column under use for residual COD stripping.

Design Implications

Because phosphate removal, as well as overall effluent quality requirements are becoming more severe, secondary treatment design parameters may well have to be considered in terms of findings such as those reported in this paper. Thus, it may very well be necessary to:

1) Provide much higher aeration rates and/or efficiencies than now is usual.

2) Design for nitrification since completion of the carbonaceous oxygen demand appears necessary. Methods of nitrate reduction to nitrogen gas are present so an increased removal of both nutrients is possible.

3) Send all waste and raw primary sludge to solids

treatment with no recycling of supernatant, filtrate, centrate, decantate, or other nutrient rich streams to the aeration process.

4) Consider solids treatment and handling in terms of phosphate and other important ion removal from the receiving waters.

5) Provide a tertiary filter at the end of secondary sedimentation to insure that no insoluble phosphorous as well as organic or other solid material leaves the facility.

6) Consider tank design in terms of the higher air rates and the possibility that a given volume may be able to handle a substantially larger flow if air can be supplied.

Barnard, J.L.

Cut P and N without Chemicals.

Water and Wastes Engineering. 11:33-36. July 1974.

Key Words: ammonia, nitrates, phosphates.

Abstract:

This article discusses changes in the operating parameters of the modified activated sludge process to maximize removals of P and N.

Barnes, G.E.

Disposal and Recovery of Electroplating Wastes.

JWPCF. 40(8):1459-1470. August 1968.

Key Words: cyanides, chlorination.

Abstract:

The term "destruction" is particularly appropriate to the chlorination of cyanide-bearing rinse waters, wherein the oxidizing action of the chlorine actually destroys the cyanide radical CN^- by breaking it down into its carbon and nitrogen components, thus forming non-toxic compounds. The term also is used to indicate the precipitation of metals carried in solution in certain rinses, to form insoluble hydroxides which are removed readily by settling with or without settling aids.

A diagram of a large waste treatment plant using destruction methods for plating room wastewaters is shown in the article. Its principal elements are accumulation tanks and treatment tanks. The accumulation tanks receive a day's flow, and each day's flow is sent to the treatment tanks. Each batch then is analyzed for chemical requirements and put through the treatment cycle.

In the treatment cycle for the cyanide-bearing wastes, the whole volume in the treatment tank is cycled through the chlorinator to acquire the necessary dosage. The destruction of the cyanides takes place quickly, and the treated liquor can be sent to the sewer. There is no sludge disposal problem.

Baroni, C., G.J. Van Esch, and U. Saffiotti.

Carcinogenesis Tests of Two Inorganic Arsenicals.

Archives of Environmental Health. 7:668-674. 1963.

Key Words: epidemiology, arsenic.

Abstract:

Arsenic trioxide was tested by oral administration and sodium arsenate by skin application on Swiss mice. Each compound was tested in three ways: (1) alone (carcinogenesis test); (2) in combination with skin applications of the promoting agent croton oil (test for initiating action); (3) after initiation with a single skin application of 7,12-dimethylbenz anthracene or with administration of urethan by stomach tube (test for promoting action). Control groups were studied concurrently. All tests failed to show any carcinogenic, initiating, or promoting activity of the two arsenicals under the experimental conditions used.

Baross, J.A., F.J. Hanus, and R.Y. Morita.

Survival of Human Enteric and Other Sewage Microorganisms under Simulated Deep-Sea Conditions.

Applied Microbiology. 30(2):309-318. August 1975.

Key Words: epidemiology, surface water (marine), *Escherichia coli*, fecal streptococci, bacteria, coliforms.

Abstract:

The survival of pure cultures of *Escherichia coli*, *Streptococcus faecalis*, *Clostridium perfringens*, and *Vibrio parahaemolyticus* under simulated deep-sea conditions of low temperature (4°C), seawater, and hydrostatic pressures ranging from 1 to 1,000 atm was determined over a period exceeding 300 h. The viability of *E. coli* and total aerobic bacteria in seawater-diluted raw sewage subjected to these deep-sea conditions was also measured. There was a greater survival of both *E. coli* and *S. faecalis* at 250 and 500 atm than a 1 atm at 4°C. *S. faecalis* was quite insensitive to 1,000 atm, whereas with *E. coli* there was a 10-fold die-off per 50-h exposure to 1,000 atm. In contrast, *V. parahaemolyticus* and *C. perfringens* were quite sensitive to pressures exceeding 250 atm, and with both of these species there was a total loss of viability of approximately 10^8 cells per ml within 100 h at 1,000 atm and within 200 h at 500 atm. The viability of the naturally occurring fecal coliforms in sewage exposed to moderate pressures at 4° C was found to be similar to the survival patterns demonstrated with pure water.

Barrow, N.J.

Effect of Previous Additions of Phosphate on Phosphate Adsorption by Soils.

Soil Science. 118:82-89. August 1974.

Key Words: phosphates, groundwater.

Abstract:

Phosphate, at several levels of application, was incubated with four soils for 12 months or was left in contact with soil in the field for 3 years. The capacity of the soils to adsorb further phosphate and the proportion of the phosphate remaining isotopically exchangable were then measured. Previous additions of phosphate reduced the capacity of the soils to adsorb further phosphate. The results indicated that some of the phosphate had been converted into a form which was occupying phosphate adsorption sites, blocking thm from further reaction, and thus reducing the buffering capacity for phosphate.

Barth, E.F., J.N. English, B.V. Salotto, B.N. Jackson, and M.B. Ettinger.

Field Survey of Four Municipal Wastewater Treatment Plants Receiving Metallic Wastes.

JWPCF. 37(8):1101-1117. August 1965.

Key Words: chromium, copper, nickel, zinc, activated sludge, trickling filters.

Abstract:

A survey of four municipal wastewater treatment plants concerning the receipt of heavy metals, distribution of the metals in the various process outlets, and effects of the metals on the treatment efficiency, has shown satisfactory correlation with pilot plant investigations.

The results show that the plants receive metallic constituents on an almost continuous concentration basis. Several slug discharges of metals to each of the plants also were recorded. At two of the plants digester supernatant accounted for a considerable portion of the metal in the process. The findings indicate that in the range of one to nine mg/1 the heavy metals cause no serious reduction in efficiency of the aerobic or anaerobic treatment of sewage.

These studies at operating municipal plants encountered many uncontrollable variables, but the pattern of response of the plants was similar to the 100 gpd (378-1/day) pilot studies.

Barth, E.F., B.N. Jackson, R.F. Lewis, and R.C. Brenner.

Phosphorus Removal from Wastewater by Direct Dosing of Aluminate to a Trickling Filter.

JWPCF. 41(11):1932-1942. November 1969.

Key Words: phosphates, trickling filters, chemical treatment.

Abstract:

This study showed that a trickling filter containing rock media can be dosed directly with sodium aluminate to increase the efficiency of phosphorus removal. No adverse effects were noted on the physical operation of the filter or the biological slime attached to the rock media. The efficiency of the dosed filter for COD, suspended solids, and nitrogen removal was similar to that of the control filter.

The data show that doses of aluminum to phosphorus above a ratio of 1:1 did not increase the efficiency of phosphorus removal. Once the phosphorus has been insolubilized, the overall efficiency of removal depends on the particulate material being delivered to the final clarification process in a settleable form.

This study fills a void in phosphorus removal technology that existed between processes employing phosphorus removal in primary sedimentation and processes employing third-stage precipitation after the trickling filter process.

Barth, E.F., M.B. Ettinger, B.V. Salotto, and G.N. McDermott.

Summary Report on the Effects of Heavy Metals on the Biological Treatment Processes.

JWPCF. 37(1):86-96. January 1965.

Key Words: chromium, copper, nickel, zinc, activated sludge, anaerobic digestion.

Abstract:

These studies have dealt with the effects of metals on the biological sewage treatment processes; however, with the increasing reuse of surface water the metal content of the final effluent becomes important. Two researchers have commented on this point. Each of the ions considered in the metal studies has definite maximum limits either for drinking water or protection of game fish.

The importance of considering the metal content of the final effluent is illustrated by chromium. It is pointed out that 10 mg/l would not interfere with conventional activated sludge treatment or anaerobic digestion of the sludges and that about 50 percent of the metal would reach the final effluent. Chromium at this concentration would be acceptable from the standpoint of plant performance; however, the low concentration of chromium allowable in drinking water indicates that if downstream use of the final effluent from a plant receiving a 10 mg/l concentration of chromium was for this purpose, considerable dilution would be required before the supply would be acceptable.

Barton, R.R., J.D. Zeff, B. Smiley, and E. Ahladeff.

UV-Ozone Water-Oxidation/Sterilization Process.

Westgate Research Corporation, Marina del Rey, California, September 1974. 89p. (Available from National Technical Information Service (NTIS) as AD-A004 205).

Key Words: bacteria, fecal streptococci, *Escherichia coli*, ozonation, radiation treatment.

Abstract:
The purpose of this program was to determine the feasibility of purifying water using the combination of ozone and ultraviolet radiation. It was discovered from in-house efforts that this combination of purifying agents was an effective means of removing bacteria and organic contaminants in water. The initial objective of this program was to define the levels of ozone and UV radiation required to destroy predetermined concentrations of microbial contaminants and organic substances in water. These contaminants were representative of those often found in waste water effluents encountered by the Army and NASA. The study was divided into two parallel efforts, a microbiological investigation has shown that the combination of UV and ozone is more effective in destroying *E. coli*, *Streptococcus faecalis*, *Klebsiella pnumoniae* and *Acanthamoeba castellanii* than UV or ozone alone. In the organic tests, the test organic compounds selected were hydroquinone, pyrogallol, xylenol, sodium acetate and urea.

Bartsch, E.

Diazinon, II: Residues in Plants, Soil, and Water.

Residue Reviews. 51:37-65. 1974.

Key Words: pesticides, soil sterilants, surface water (fresh).

Abstract:

This article presents a good review of soil sterilant diazinon and its role in the ecosphere. Review of diazinon in water is included.

Barua, D.

Survival of Cholera Vibrios in Food, Water, and Fomites.

Principals and Practice of Cholera Control. Chapter 4: 29-31. 1970.

Key Words: Vibrio cholera, surface water (fresh), surface water (marine), groundwater, crops.

Abstract:

Survival of vibrios in water is dependent upon pH as well as bacterial, salt, and organic content. Vibrios do not survive long (7-13 days) in surface water, unless it is repeatedly contaminated.

Bascom, W.

The Disposal of Waste in the Ocean.

Scientific American. 231:16-25. August 1974.

Key Words: silver, cadmium, chromium, cobalt, copper,
iron, lead, manganese, nickel, zinc.

Abstract:

This paper discusses generalities concerning the ability of the ocean to assimilate waste.

Bauer, R.C. and V.L. Snoeyink.

Reactions of Chloramines with Active Carbon.

JWPCF. 45(11):2290-2301. November 1973.

Key Words: ammonia, chlorination.

Abstract:

The results of this study indicate that chlorine dosages below the breakpoint requirement can be used to oxidize ammonia, if chlorination is followed by contact with active carbon. Without the use of active carbon, dosages below the breakpoint result in large concentrations of total residual, whereas carbon serves to destroy both combined and free chlorine residual.

Bauer, S.B.

Heavy Metals in Lakes of the Coeur d'Alene River Valley, Idaho.

Thesis, University of Idaho, Moscow, November 1974.

Key Words: cadmium, copper, zinc, surface water (fresh), fish.

Abstract:

The Coeur d'Alene River transports heavy metals into the lateral lakes especially during high-water in the spring. However, since dilution is greatest during this time of year the concentration of dissolved metals is low. Zinc concentrations may be toxic to trout at the lake inlets, however, dissolved metals are below toxic levels in the open water areas of the lakes.

Heavy metals have accumulated to high concentrations in sediments of lakes in the Coeur d'Alene River Valley. However, these metals are probably strongly adsorbed to sediments and apparently have little effect on the biota of the lakes.

Metal concentrations in fish from several of the lakes were higher than values for fish from a control area. However, in general, the levels found were not excessive and illustrate that fish are not accumulating these contaminants from the lake environment. Determination of zinc, copper, and cadmium in tissues of fish then appears to be a poor indicator of heavy metal pollution.

In order to clarify these points, further studies should examine other species of fish in the drainage especially Salmonids which support the bulk of the sport fishery. In addition, fish should be analyzed for other metals which occur in the mining wastes such as lead and antimony.

Many physiological changes in fish have been demonstrated at concentrations that are well below documented lethal limits. Such sublethal effects need to be assessed before the impact of metals on these fish populations can be fully understood.

Baughman, G.L., J.A. Gordon, N.L. Wolf, and R.G. Zepp.

Chemistry of Organomercurials in Aquatic Systems.

EPA-660/3-73-012, Southeast Environmental Research Laboratory, Athens, Georgia, September 1973. 109p. (Available from National Technical Information Service (NTIS) as PB-226 889).

Key Words: mercury, surface water (fresh).

Abstract:

Studies are needed to elucidate the rates and mechanisms of the release of dimethylmercury and elemental mercury from sediments to overlying water. Because these materials are non-ionic and have a significant vapor pressure, they may play an important role in mercury cycling through loss at the air-water interface.

Calculations presented here indicate that elemental mercury and dimethylmercury are likely to volatilize from the aquatic environment. Because little is known about the behavior of gaseous mercury species in the atmosphere, research should be undertaken to determine the fate of these materials.

Bausum, H.T., S.S. Schaub, M.J. Small, J.A. Highfill, and C.A. Sorber.

Bacterial Aerosols Resulting from Spray Irrigation with Wastewater.

U.S. Army Medical Research and Development Laboratory, Fort Detrick, Md., June 1976. 140p.

Key Words: bacteria, virus, gravity separators, activated sludge, trickling filters, chemical treatment, ponding/land application, chlorination, ozonation, groundwater.

Abstract:

A model was developed to permit prediction of pathogen concentration downwind from a spray source. Considered in the model are the pathogen levels present in the effluent, the percentage of wastewater aerosolized, and meteorological conditions. An excellent comprehensive literature review is included. Field data was collected to compare with the model.

Baxter, S.S., C.F. Guarino, R.A. Erb, and C.T. Davey.

Philadelphia's Ocean Sludge Disposal Experience and Studies.

Presented at the 44th Annual Conference of the Water Pollution Control Federation, 1971.

Key Words: cadmium, chromium, lead, manganese, nickel, zinc.

Abstract:

The results at the half-way mark of this investigation are summarized below:

1. Sediment samples taken from the center of the disposal site and the immediate vicinity (including low spots) consist of clean sand, along with gravel and shell fragments.

2. In all sediment samples taken in and around the disposal area, no black sludge or H_2S odor emitting samples were found.

3. At the center of the sludge disposal area, starfish, sand dollars, hermit crabs, and snails were found in good health.

4. Fish specimens collected at the disposal site included winter flounder, mackeral, stargazer, long horned sculpin, and spiny dogfish.

5. Dissolved oxygen measurements of bottom, middle, and surface waters at various points within and surrounding the site show no signs of oxygen depletion or sag.

6. Coliform levels in all bottom, mid, and surface waters are zero.

7. There are no indications of significant concentrations of heavy metals in surf clams and other macrofauna collected in the area.

Becker, E.R.

BOD, Solids and Nutrient Removal by Foam Flotation.

EPA-670/2-73-096, U.S. Environmental Protection Agency,
Cincinnati, Ohio, June 1974. 71p.

Key Words: BOD, suspended solids, phosphates, foam flotation.

Abstract:

The results of a field demonstration project to investigate the removal of BOD, suspended solids and nutrients from a secondary effluent flowstream by the foam flotation process are presented. Two major tasks were accomplished: (1) operation of and the accumulation of data from a 0-10 gpm foam flotation pilot plant using secondary effluent from the San Jose-Santa Clara Water Pollution Control Plant, and (2) economic evaluation of the foam flotation process. It was found that efficient phosphorus and suspended solids removals and an improved effluent saturated with oxygen could be effected by the foam flotation process. Based on a 10 MGD plant, the projected costs for the foam flotation process were shown to be 5.76 cents/1000 gallons for chemicals and power.

Beckman, W.J., R.J. Avendt, T.J. Mulligan, and G.J. Kehrberger.

Combined Carbon Oxidation-Nitrification.

JWPCF. 44(10):1916-1930. October 1972.

Key Words: ammonia, nitrates, suspended solids.

Abstract:

The study's findings are summarized below:

1. Biological nitrification is attainable in a combined carbon oxidation-nitrification activated sludge facility.

2. The nitrification rate depends on temperature, and optimum temperature during the experimentation period was 65°F (18.3°C).

3. For nitrification with the mixed liquor at 50° to 65°F, F:M ratios of 0.25 or less are optimum.

4. Sludge ages greater than 3 days are needed; optimum age is greater than 6 days.

5. Removal of relatively small amounts of ammonia nitrogen during periods of critical stream flow is economically feasible with breakpoint chlorination.

6. A preliminary study of the receiving stream relative to its ability to assimilate BOD and ammonia nitrogen at various temperatures, flows, and other conditions is extremely important in determining the extent of the application of tertiary or advanced wastewater treatment.

7. Average BOD and SS removals greater than 95 percent through primary and secondary treatment and microstraining were observed throughout the study period.

8. Within the pH ranges studied (7.0 to 8.0), the pH had no significant influence on the rate of ammonia removal.

9. Laboratory investigations of the effect of heavy metals on nitrification indicated that slug doses of copper and chromium at 1.0 mg/l

or less did not retard the reaction. Slug dosages of zinc and nickel, however, retarded the rate of nitrification at concentrations greater than 0.5 mg/l. Complete inhibition was not observed with zinc and nickel concentrations as high as 3.0 mg/l.

10. Maintenance of a DO concentration of 2.0 or more in the aeration tank effluent did not permit denitrification to occur in the final settling tanks provided that an excessive sludge blanket was not permitted to form.

11. Laboratory investigation showed that high rates of denitrification could be obtained using clarified nitrified effluent when detention times of 5 hr, extremely low DO levels, and influent COD values greater than 150 mg/l (methanol supplementation) were maintained.

Beeckmans, J.M. and P.C. Ng.

Pyrolyzed Sewage Sludge: Its Production and Possible Utility.

Environmental Science and Technology. 5:69-71. January 1971.

Key Words: COD, heat treatment.

Abstract:

Filtered sludge from a municipal activated sludge plant was pyrolyzed in a continuous-feed, multiple-hearth furnace. The carbon content of the pyrolysate under optimum operating conditions was 14.1%. The pyrolysate was crushed 70 to 100 mesh, and its ability to adsorb COD and the dye crystal violet was measured. Parallel adsorption tests were made with fly ash and activated coconut charcoal. The pyrolysate was found to be intermediate in its adsorbing capacity between fly ash and activated coconut charcoal for both adsorbates, suggesting that it could prove useful as a tertiary treatment agent in wastewater renovation.

Bellar, T.A., J.J. Lichtenberg, and R.C. Kroner.

The Occurrence of Organohalides in Chlorinated Drinking Waters.

National Environmental Research Center, Cincinnati, Ohio, November 1974. 21p. (Available from National Technical Information Service (NTIS) as PB-238 589)

Key Words: synthetic/organics, drinking and recreational water, effluent characteristics.

Abstract:

Chloroform and other trihalogenated methanes have been detected in several municipal water supplies. The highest concentrations (37 to 150 μg/l) of these compounds were found in finished waters having surface waters as their source. These compounds form as a result of chlorination processes during water treatment. The repeated addition of chlorine at various stages of the treatment process plays an important role in determining the ultimate concentrations of organohalogens that occur, since a primary limiting factor is the presence of free chlorine in the water.

Although the trihalogenated compounds resulting from chlorination are not an acute hazard to man at the levels detected [oral lethal dose of chloroform to mice is 120 mg/Kg (1)], their presence suggests the need to monitor finished waters for these and other organohalogens and to determine whether there may be chronic effects. There is a need to develop analytical methodology so that the chemistry of the chlorination process can be fully studied and understood.

In addition to chloroform, several other halogenated aliphatic and aromatic compounds were detected in a sewage treatment plant influent and effluent waters.

Bellar, T.A., J.J. Lichtenberg, and R.C. Kroner.

The Occurrence of Organohalides in Chlorinated Drinking Waters.

JAWWA. 166:703-706. December 1974.

Key Words: synthetic /organics, chlorination.

Abstract:

This paper provides a general discussion on the production of organics by the disinfection (halogens) processes.

Benarde, M.A.

Land Disposal and Sewage Effluent: Appraisal of Health Effects of Pathogenic Organisms.

JAWWA. 65(6):432-440. June 1973.

Key Words: polio virus, salmonella, shigella, surface water (fresh).

Abstract:

This article provides general discussions on the public health ramifications of land disposal of sewage effluent.

Bender, M.E. and D.L. Correll.

The Use of Wetlands as Nutrient Removal Systems.

Chesapeake Research Consortium, Baltimore, Maryland, June 1974. 15p. (Available from National Technical Information Service (NTIS) as PB-241 002).

Key Words: nitrates, nitrites, phosphates, surface water (marine).

Abstract:

Data derived from three wetland study sites in the Chesapeake Bay show that regularly flooded tidal marshes should not be considered as sinks for available forms of the nutrients -- nitrogen or phosphorus. Although transformation of the incoming or applied marsh and exported as ammonia and dissolved organic nitrogen to the estuary, there is little if any net loss of available nitrogen or phosphorus to the marsh. Seasonally the highest exports of dissolved inorganic phosphorus and ammonia occurred during the summer. These results were arrived at utilizing two different methodologies -- the first employed fertilization or loading experiments in combination with tracers while the other determined natural flux at two undisturbed study sites. The important management implication of these results is that the contention that marshes have considerable value as nutrient removal systems appears to be unfounded, at least for the medium salinity marshes of Chesapeake Bay.

Bendixen, T.W., R.D. Hill, F.T. DuByne, and G.G. Robeck.

Cannery Waste Treatment by Spray Irrigation-Runoff.

JWPCF. 41(3):385-391. March 1969.

Key Words: COD, phosphates, suspended solids, crops.

Abstract:

Over a 12-yr period since 1954, a land disposal system serving a cannery in northwest Ohio has been developed gradually from a complete containment spray irrigation system into a spray irrigation-runoff system.

Over a 5-yr period, 1961 through 1965, when it operated as a spray-runoff system, an average of 30 percent of the sprayed volume ran off and contained only about 9 percent of the applied COD. Runoff volume and quality decreased as the hydraulic load increased.

During the 1964 and 1965 seasons, detailed monitoring of 3 of 5 sub-watersheds indicated that 30 to 40 percent of the applied waste ran off, 30 percent was lost by evapo-transpiration, about 25 percent was stored in the soil or lost through percolation, and about 5 percent evaporated directly from the spray.

Infiltration rates tended to decrease during the spray season but recovered between seasons.

The remnants of a tile drainage system in one watershed appeared to have a major influence in reducing direct runoff volume and improving quality. Removals of COD, nitrogen, phosphates, and suspended solids were in the order of 95, 93, 84, and 97 percent, respectively. Quality of runoff was uniform throughout the season except for the influence of four large rainstorms. Runoff during these rainstorms contributed from 18 to 30 percent of the total season runoff and from 8 to 55 percent of the total season organic and nutrient load.

Average seasonal organic and nutrient load from the spray system was of the same order of magnitude as the annual loads from agricultural watersheds.

Bennett, G.W., D.L. Ballee, R.C. Hall, J.F. Fahey, W.L. Butts, and J.V. Osmun.

Persistence and Distribution of Chlordane and Dieldrin Applied as Termiticides.

Bulletin of Environmental Contamination and Toxicology. 11: 64-69. January 1974.

Key Words: pesticides, chlorinated hydrocarbons, dieldrin, groundwater, surface water (fresh).

Abstract:

Some chlorinated hydrocarbon compounds applied to soil under and around buildings are very effective for subterranean termite prevention and control. This study reports the investigation of termiticides which behaved in a similar manner in soil beneath and around treated structures and determined to be of no environmental concern.

Benson, N.R.

Zinc Retention by Soils.

Soil Science. 101(3):171-179. March 1966.

Key Words: zinc, ponding/land application.

Abstract:

It is not within the scope of this paper to interpret the behavior of the various ions in exchange reactions. A few observations, however, are worthy of note. In the Ritzville and Ephrata soils, K substituted for Zn, ion for ion, an effect that was not expected. These two soils had high silt and low clay and organic matter contents. In the Selah and Wenatchee soils K substituted for Zn more closely on a chemical equivalent basis. These two soils had relatively high clay and organic matter contents. In Hood soil there was very little substitution of K for Zn. The prominent feature of this soil was its high organic matter content. From this limited data, it appears that the capacity for K to substitute for Zn is strongly affected by the organic fraction.

The Hood and Lick soils were forest soils, whereas the others were desert soils. The differences in behavior of the Hood and Lick soils from the others could be due to properties not determined. The fact that these soils do not produce Zn-deficient fruit trees may be significant, at least in the extrapolation of these studies to field use.

The data presented has shown that the application of Zn salts to soils results in high soil Zn concentrations. Not presented was data showing that apple seedlings quickly die when planted in a soil having 20 percent or more of the exchange capacity Zn-saturated. It was shown that apple seedlings survive and make root growth in a soil having up to 12 percent of the CEC as Zn. In all of the noncalcareous soils studied that produce Zn-deficient fruit trees, tolerable concentrations of Zn would result if treated with a mixture of $ZnSO_4$-K_2SO_4, having a Zn per K ratio of 1/3. This offers a firm basis to test a field treatment that promises a long-lasting cure for Zn-deficient fruit trees.

A soil treatment that would result in a soil Zn concentration sufficiently dispersed for trees to absorb adequate Zn might require an acidifying material such as S or H_2SO_1 in addition to, or instead of, part of the K_2SO_1. The acid would prevent precipitation of the Zn and reduce the amount of Zn retained in exchangeable form in the upper profile. The subsequent leaching with $CaSO_4$ formed by the action of

the acid acting in the soil $CaCO_3$ would replace more Zn and move it deeper into the soil. The effectiveness of such a treatment needs further study.

Benzie, W.J. and R.J. Courchaine.

Discharges from Separate Storm Sewers and Combined Sewers.

JWPCF. 38(3):410-421. March 1966.

Key Words: ammonia, phosphates, coliforms, fecal streptococci, combined municipal and/or sewer systems.

Abstract:

A comparison of mean median values indicates that considerably larger quantities of total coliforms, fecal coliforms and fecal streptococci are found in the discharges from a combined system rather than a separate storm sewer system. Discharges from a separate storm sewer system contain significant quantities of fecal organisms, presumably of animal origin.

Berg, E.L., C.A. Brunner, and R.T. Williams.

Single Stage Lime Clarification of Secondary Effluent.

Water and Wastes Engineering. 7(3):42-46. March 1970.

Key Words: BOD, COD, chemical treatment.

Abstract:

This study was undertaken to produce suitable clarified water from secondary effluent for an advanced waste treatment system which includes granular activated carbon treatment and electrodialysis. The clarifier was operated at various pH values to ascertain also the effects upon those constituents normally present in secondary effluent.

Results showed that a lime clarification system can be an effective and economical tool for the clarification of relatively hard wastewaters. Water of high clarity, however, is obtainable only during optimal operation of the biological oxidation process. The system also removed large amounts of phosphate, a major nutrient that supports algal life. The economics of the system are comparable with other forms of clarification.

Berg, G.

Integrated Approach to Problem of Viruses in Water.

Journal of the Sanitary Engineering Division, ASCE.
97(SA6):867-882. December 1971.

Key Words: viruses, gravity separators, activated sludge, chemical treatment, chlorination.

Abstract:

Primary settling removes little virus in 3 hr. and only about 40 to 70% in 24 hrs. In theory, activated sludge can remove 99% of virus present, but field studies indicate the figure to be somewhat less. Chemical coagulation has been found to remove up to 90%. Hypochlorous acid (HOCl) is one of the fastest virucides known.

Berg, G.

Microbiology-Detection, Occurrence, and Removal of Viruses.

JWPCF. 46(6):1408-1413. June 1974.

Key Words: epidemiology, viruses.

Abstract:

A review article on detection, occurrence, and removal of viruses from wastewater, its findings were developed during the period of 1973.

Berg, G.

Reassessment of the Virus Problem in Sewage and in Surface and Renovated Waters.

In: Advances in Wastewater Research. Pergamon Press, New York. B/14/28/1-8. 1972.

Key Words: viruses, surface water (fresh).

Abstract:

This very general article sets standards and delineates research needs in the field of viruses in surface and renovated waters.

Berg, G.

Removal of Viruses from Sewage, Effluents, and Waters. 1: A Review.

World Health Organization Bulletin. 49:451-460. May 1973.

Key Words: viruses, gravity separators, trickling filters, activated sludge, ponding/land application, filtration, chemical treatment, chlorination, ozonation, radiation treatment.

Abstract:

All sewage and water treatment processes remove or destroy viruses. Some treatment methods are better than others, but none is likely to remove all of the viruses present in sewage or in raw water. Primary settling of solids probably removes a great many of the viruses in sewage because viruses are largely associated with the solids. Long storage of effluents or water is destructive to viruses. Activated sludge is the best biological method for removing viruses from sewage. Trickling filters and oxidation ponds are erratic, the latter probably because of short-circuiting. Coagulation with metal ions is the most effective single treatment method for removing viruses from sewage and from raw waters, according to laboratory studies at least. Lime is the best coagulant for these purposes in the rapidly virucidal high pH range. Polyelectrolytes also can sediment viruses. Rapid filtration through clean sand does not remove viruses, but filtration of coagulated effluents does, probably because the layering floc itself adsorbs viruses. Clays and carbon adsorb viruses to some extent, but the process is not efficient. Ultimately, disinfection should help to produce virus-free waters for drinking and virus-free effluents for discharge into waters with which man may come into contact. Because disinfection is not a simple matter, disinfectants must be selected according to need. Effluents and waters containing solids can probably be disinfected only by heat or by penetrating radiation; waters discharged into streams should not be disinfected with anything that will injure or kill aquatic life (unless the toxic products can be neutralized); and drinking-waters should carry a disinfecting residue.

This article provides a good review on the removals of viruses.

Berg, G.

Removal of Viruses from Sewage, Effluents and Waters. 2: Present and Future Trends.

World Health Organization Bulletin. 49:461-469. May 1973.

Key Words: viruses, gravity separators, ponding/land application, activated sludge, chemical treatment, filtration, chlorination, ozonation, radiation treatment, anaerobic digestion.

Abstract:

Because large variations occur in the concentrations of viruses that enter treatment plants from season to season and from place to place, and even during a 24-hour period, field studies on the removal of viruses by treatment processes require temporal coordination of sampling. Quantitative methods for concentrating viruses must be developed to measure accurately the efficiency of virus removal by treatment processes in field situations. Extended settling, and storage of sewage and raw waters, reduce virus levels and deserve further study. Oxidation ponds must be reevaluated with regard to temporal matching of influent and effluent samples and with special care to prevent short-circuiting. Conventional and modified activated sludge plants must be reassessed with temporal matching of samples. Coagulation of viruses with metal ions requires field evaluation, and virus removal by filtration through sand and other media, under constant salt and organic loadings, needs both laboratory and field evaluation. A comparative study of water disinfectants related to specific conditions is needed. The toxicity, carcinogenicity, and teratogenicity of products resulting from disinfection must also be assessed. Other matters for investigation are: methods for quantitatively detecting viruses adsorbed on solids, the virus-removal capability of soils, better virus indicators, virus concentration in shellfish, the frequency of infection in man brought about by swallowing small numbers of viruses in water, the epidemiology of virus infection in man by the water route, the effect of viruses of nonhuman origin on man, and the occurrence of tumour-inducing agents in water.

Berg, G.

Removal of Viruses from Water and Wastewater.

In: Proceedings of the Thirteenth Water Quality Conference; Virus and Water Quality: Occurrence and Control, University of Illinois, February 1971. pp. 126-136.

Key Words: bacteria, gravity separators, activated sludge, chemical treatment, trickling filters, adsorption/ion exchange, ponding/land application.

Abstract:
There is not yet available a single method that completely recovers all viruses from sewage. Primary settling, which is used in most communities, removes little virus. Several biological treatment methods such as activated sludge, stabilization ponds, and trickling filters may be used for virus removal but with widely varying results. As costs become a little less important, and the quality of our waters a little more important, chemical and physical treatment procedures may find increasing application both in treating raw sewage and secondary effluents when total renovation is the goal.

Berg, G.

Transmission of Viruses by the Water Route.

Interscience Publishers, New York, December 1965.

Key Words: epidemiology, viruses.

Abstract:

This book is based on a symposium held December 6-8, 1965, in Cincinnati, Ohio.

It deals with:
- epidemiology,
- quantitative recovery of viruses from dilute suspensions,
- the minimal infective dose,
- viruses in water, and
- survival of viruses in waste and wastewater.

The contents in this volume are summaries of the knowledge available up to 1965.

Berg, G.

Virus Transmission by the Water Vehicle. I: Viruses.

Health Laboratory Science. 3(2):86-88. April 1966.

Key Words: viruses, drinking and recreational water.

Abstract:

This volume is the introduction to a series of articles.

This series includes only selected material. Rather than a literature review, several of which have been published recently, this series includes only representative material from some of the more cogent reports, and is directed towards the presentation of a concise comprehensive picture of the present day knowledge of the effect of water and sewage treatment processes on the removal and destruction of viruses.

Berg, G.

Virus Transmission by the Water Vehicle. II: Virus Removal by Sewage Treatment Procedures.

Health Laboratory Science. 3(2):90-100. April 1966.

Key Words: viruses, gravity separation, activated sludge, trickling filters, chlorination.

Abstract:

This is the second in a series of three articles. What appears to be most important at the moment is that sewage effluents after secondary treatment and even after chlorination are not free of viruses.

While studies are needed for improvement of sewage treatment procedures, immediate concern for potable waters demands consideration of the ability of water treatment processes to produce finished waters free of viruses. This consideration is the subject of the third paper of this series.

Berg, G.

Virus Transmission by the Water Vehicle. III: Removal of Viruses by Water Treatment Procedures.

Health Laboratory Science. 3(3):170-181. July 1966.

Key Words: viruses, chlorination, coliforms, filtration, nitrification/denitrification.

Abstract:

This is the third in a series of three articles and reviews treatment systems being applied up to 1966.

Berg, G. and F. D. White.

Viruses in Waste, Renovated, and Other Waters; 1974 Literature Abstracts.

EPA-670/9-75-007, National Environmental Research Center, Cincinnati, Ohio, Methods Development and Quality Assurance Research Laboratory, June 1975. 40p. (Available from National Technical Information Service (NTIS) as PB-245 957).

Key Words: epidemiology, viruses.

Abstract:

The bibliography contains abstracts of published papers on viruses in water, wastewater systems, and sewage for 1974. The abstracts cover the detection, removal, and concentration of viruses from various sources.

Berg, G., R.B. Dean, and D.R. Dahling.

Removal of Poliovirus 1 from Secondary Effluents by Lime Flocculation and Rapid Sand Filtration.

JAWWA. 60(2):193-198. February 1968.

Key Words: polio virus, filtration, chemical treatment.

Abstract:

About 98.6 - 99.995 percent of the virus was removed followed by sand filtration following flocculation. The extent of removal depended upon the lime concentration, and consequently on the pH to some extent.

Whether viruses not as sensitive to pH levels above 10.8 would be destroyed as readily remains to be determined.

The findings of this paper can be summarized below:

1. Poliovirus 1 (LSc vaccine) inoculated into secondary effluent was not rapidly adsorbed or inactivated and could be recovered readily.

2. Flocculation of secondary effluent with 200-500 mg/l of lime removed less than 70-99.86 percent of polio virus 1 (LSc vaccine). The amount of removal depended upon the concentration of lime and the pH level attained.

3. Filtration through 8 in. of sand removed from 82 to greater than 99.8 percent of the virus.

4. Total removal of virus by lime flocculation and sand filtration ranged from 98.6 to greater than 99.997 percent.

Berg, J.W. and F. Burbank.

Correlations between Carcinogenic Trace Metals in Water Supplies and Cancer Mortality.

Annals of the New York Academy of Sciences. 199:249-261. June 28, 1972.

Key Words: epidemiology, heavy metals.

Abstract:

Concentrations of eight carcinogenic trace metals in water supplies were compared with state cancer mortalities for major water basins in the United States. No significant correlations were found for iron, cobalt, and chromium. Nickel concentrations correlated with mouth and intestinal cancer death rates and arsenic concentrations with mortality from larynx cancer, eye cancer, and myeloid leukemia, but these cannot be interpreted biologically. Beryllium which produces bone cancer in animals, was correlated with bone cancer mortality as well as with mortality from breast and uterine cancers, but association was weak in subgroups. Lead, a renal carcinogen in animals and a hematopoietic poison, was correlated with mortality from kidney cancer, leukemias, and lymphonias as well as stomach, intestinal, and ovarian cancers. Cadmium concentrations were correlated most closely and most frequently with cancer death rates, but the distribution of the metal producing these results are not in agreement with other reports.

Berkihiser, E.

Decrease of DDT in Mussels.

Southern California Coastal Water Research Project Annual Report. El Segundo, Ca. , June 30, 1974. pp. 101-103.

Key Words: pesticides, DDT, shellfish.

Abstract:

Intertidal mussels are useful indicators of the relative amounts of DDT and PCB contamination in nearshore waters. The Coastal Water Projects' 1971 survey of these synthetic organies in Mytilus californianus from stations throughout the Bight revealed a distinct correlation between the concentrations of both total DDT and PCB 1254 in the tissue of a mussel and the proximity of the station from which the mussel was taken to the Palos Verdes Peninsula, a region of major DDT and PCB inputs. This study suggests that the mussel will rapidly reflect changes in the seawater concentrations of chlorinated hydrocarbons.

Bernard, H.

Alternative Methods for Sludge Management.

In: Municipal Sludge Management; Proceedings of the National Conference on Municipal Sludge Management, 1974. pp. 11-19.

Key Words: anaerobic digestion, incineration, sanitary landfill, agriculture.

Abstract:

There are many alternative methods of handling and disposing of sludge materials from wastewater treatment plants. No single system is capable of solving all disposal problems. Various sludge processing systems as well as incineration, land disposal, composting, resource recovery, etc. are discussed.

Bernardin, F.E.

Cyanide Detoxification Using Adsorption and Catalytic Oxidation on Granular Activated Carbon.

JWPCF. 45(2):221-231. February 1973.

Key Words: cadmium, copper, zinc, cyanides, chemical treatment, effluent characteristics.

Abstract:

It has been demonstrated in laboratory and field tests that catalytic oxidation of cyanide over activated carbon is a feasible means for treatment of cyanide-containing wastes. Further, it has been shown that the addition of copper as cupric ions has a beneficial effect on the reaction. The process has been shown to work on copper, zinc, and cadmium wastes and on coke plant wastes when proper treatment is used. The proper treatment is defined as removal of oils and tars, which would foul the carbon surface, and removal or prevention of excess iron contamination, which would form oxidation-resistant complexes. In the treatment of plating wastes, it was also found that coagulation treatment could remove the plating metal and produce a sludge which might be reused.

The major advantages to this system are the mild conditions under which it works, the relatively low operating cost, and the fact that the system can be run unattended either through automation or recycling.

Bernhardt, H., J. Clasen, and H. Schell.

Phosphate and Turbidity Control by Flocculation and Filtration.

JAWWA. 63(6):355-368. June 1971.

Key Words: phosphates, suspended solids, filtration, chemical treatment.

Abstract:

The Wahnbach Reservoir in the Federal Republic of Germany, since its impoundment, gradually has developed heavy deposits of algae -- most of which thrive on the phosphates from agricultural runoff. To stifle the algae, tests were run to determine the best method for eliminating their nourishment. This article relates findings that, for this reservoir's particular problems, were found to be the most efficient and economic methods.

Berrow, M.L. and J. Webber.

Trace Elements in Sewage Sludges.

Journal of the Science of Food and Agriculture. 23:93-100. 1972.

Key Words: aluminum, boron, chromium, copper, cobalt, iron, lead, manganese, molybdenum, nickel, tin, zinc.

Abstract:

The elements Cu, Sn and Zn are present in the sewage sludges in amounts approximately 40 times as great as in soils. For Ag, Bi and Pb the factor is probably lower. Of these elements, Zn in particular is present in sludges in a highly soluble form, the median figure for soluble Zn being over 500 times that found in soil. The only other element commonly present in a soluble form in large amount relative to soil is Cu. Although the percentage solubility of Ni in sludges is generally high relative to that of Ni in soil, the sludge values are very high only in a few cases. Manganese is the element showing the highest mean percentage solubility but, as the median value is only 6 times as great as the corresponding value for soil, it appears unlikely that Mn toxicity in crops would arise from the use of sewage sludges.

When both total and soluble figures are considered in relation to normal levels in soil, it appears that levels of Zn, particularly available Zn, in the soil are likely to be greatly increased by the addition of sewage sludge. The same applies, but to a lesser extent, to Cu. Plant growth problems are likely to arise when the acetic acid soluble Zn level rises to greater than 100 parts/million in the soil. Cases of copper toxicity in crops following the repeated use of copper fungicidal sprays in vineyard and orchard soils have been reported, these being summarized by Delas. Nickel and Cu have been shown in pet experiments (unpublished results) carried out by N.A.A.S. to be considerably more toxic than Zn, confirming the finding of Hunter and Vergnano in pet experiments with oats, that Ni was the most toxic, followed by Cu and other heavy metals in the series Ni, Cu, Co, Cr, Zn, Mo and Mn. Complete crop failure in the field has been reported in Scottish soils containing 50-100 parts/million acetic acid-soluble Ni (Mitchell), and in Ni-rich soils of ultrabasic origin from many other sources.

A dressing of sewage sludge of 10 tons of dry matter per acre, (25t/ha), with the median contents of trace elements detailed in Table 1 is equivalent to adding approximately 33 parts/million Zn, 10 parts/million Cu, 8 parts/million

Pb, 5 parts/million Mn, 3 parts/million Cr, 1 parts/million Ni, 0.6 parts/million B and 0.1 parts/million Co. After annual application for 7 years, such treatments would raise the total Zn content of a typical soil to greater than 300 parts/million, the top of the normal range for total Zn in soils. The level of acetic acid-soluble Zn could be increased by 12 parts/million with each dressing of sludge and long-term field experiments (LeRiche) suggest that soluble Zn added to soil as regular dressings of sludge persists in this form, maintaining high levels of soluble Zn in the soil for at least 8 years. The same dressing of a sludge containing the highest total levels found in the 42 sludges (Table 1) would add each year approximately 560 parts/million Zn, 110 parts/million Cr and Cu, 56 parts/million Ni, 33 parts/million Pb and 11 parts/million B to the soil. It can be seen that the use of such materials as fertilizers is not without serious hazards, particularly when used at heavy rates of application over a number of years. The wide variation in trace element contents of sludges from different towns make it advisable that the composition of individual sludges should be known before their use as a fertilizer.

Bertrand, G.L.

Accumulation of Mercury of Fish and Turtles of the Little Piney River.

University of Missouri-Rolla, Department of Chemistry, June 1974. 7p. (Available from National Technical Information Service (NTIS) as PB-239 253).

Key Words: mercury, surface water (fresh).

Abstract:

Trout that had been continuously frozen since they were taken from Missouri streams in the 1946-50 period were analyzed for mercury. These analyses (flameless atomic absorption) were compared with those of the same species collected recently from the same streams. The older fish had a much higher mercury content (about 3 ppm mercury). Mercury content of trout and turtles caught in 1974 ranged from 0.2 to 0.4 ppm. Two explanations are suggested for the higher mercury content of the older fish: fungicides, containing mercury, formerly added as seed treatments are no longer used, and most of the older fish were raised under natural conditions, while most current catches are now raised in hatcheries and regularly released in the streams.

Bertucci, J., D. Zenz, and C. Lue-Hing.

Report on the Virological Studies of Big Creek and Evelyn Reservior in Fulton County, Illinois, February, 1973.

Metropolitan Sanitary District of Greater Chicago, September 1973. 6p.

Key Words: viruses, surface water (fresh).

Abstract:

This report presents a study of virus densities in surface waters; the study is part of a larger program to monitor possible virus pollution of surface waters by land applied liquid fertilizer. From the data obtained, it can be stated that there is no evidence of viral pollution caused by the Metropolitan Sanitary District of Greater Chicago operations. The levels of viruses detected at this time were no higher than background levels detected previous to the MSDGC operations.

Bertucci, J., C. Lue-Hing , D.R. Zenz, and S.J. Sedita.

Studies on the Inactivation Rates of Five Viruses during Anaerobic Sludge Digestion.

Metropolitan Sanitary District of Greater Chicago,
September 1975. 34p.

Key Words: coxsackie virus, ECHO virus, polio virus, nitrates, phosphates, suspended solids, viruses, iron, manganese, zinc, anaerobic digestion.

Abstract:

The use of anaerobically digested municipal sludge as a fertilizer and soil amendment is becoming a widely accepted method of sludge disposal both in Europe and the United States. The possibility of increased virus burden to the environment due to sludge application was a major concern of the Metropolitan Sanitary District of Greater Chicago at its Fulton County Land Reclamation Site in Southern Illinois.

The viruses studied included coliphage MS-2, polio virus-1, coxsackie viruses A-9 and B-4, and ECHO virus-11. Average individual virus inactivation rates were found to range from 74.9 to 97.1 percent after 24 hours to 93.7 to 99.9 percent after 48 hours.

Besik, F.K.

Renovating Domestic Sewage to Drinking Water Quality.

Water and Pollution Control. 111(4):58-63,97. April 1973.

Key Words: ammonia, BOD, nitrates, phosphates, total organic carbon, activated sludge, adsorption/ion exchange.

Abstract:

The renovation of waste water using biological/physical-chemical treatment is discussed.

Besik, F.K.

Waste Water Reclamation in a Closed System.

Water and Sewage Works. 118(7):213-219. July 1971.

Key Words: chlorides, phosphates, total organic carbon.

Abstract:

This report provides a good review of recycling water. Mass balances are described.

Bewers, J.M., I.D. Macaulay, and B. Sundby.

Trace Metals in the Waters of the Gulf of Saint Lawrence.

Canadian Journal of Earth Sciences. 11(7):939-950. July 1974.

Key Words: cadmium, cobalt, copper, iron, lead, nickel, zinc, surface water (marine).

Abstract:

Concentrations of the trace elements iron, cobalt, nickel, copper, zinc, cadmium, and lead were measured in samples collected from the waters of the Gulf of St. Lawrence. Cobalt, cadmium, and lead occurred at or below the detection limits of the analytical method. The mean concentrations of nickel, copper, and zinc were $0.4 \mu g l^{-1}$, $0.6 \mu g l^{-1}$ and $1.8 \mu g l^{-1}$ respectively, and there was no evidence that local conditions influence their distribution. The distribution of dissolved and colloidal iron is related to dilution and precipitation processes which occur as fresh and saline waters are mixed. The particulate iron distribution is largely governed by water circulation patterns and settling.

Bingham, F.J.

Phosphorus.

In: Diagnostic Criteria for Plants and Soils. Homer D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 324-361.

Key Words: phosphates, ponding/land application, land reclamation, groundwater, air, crops.

Abstract:

Visual symptoms characteristic of phosphorus deficiency are not always definite enough to permit an accurate appraisal. However, certain symptoms are recognized, and can be confirmed by plant and soil analysis. The author describes visual symptoms of phosphorus deficiency, indicator plants for phosphorus deficiency and excess, tissue analysis values, soils in which phosphorus deficiency most commonly occurs, and soil management and other practices which affect phosphorus availability, soil analysis values of significance (the Jenny, Vlamis, and Martin lettuce test, the Neubauer-Schneider test, Thornton's technique, soil plague tests, "A" value technique and chemical soil tests), and control of phosphorus deficiency and excess.

Birge, W.J., J.J. Just, A. Westerman, and A.D. Rose.

Sensitivity of Vertebrate Embryos to Heavy Metals as
a Criterion of Water Quality. Phase I.

Kentucky Water Resources Institute, Lexington, June 1973.
38p. (Available from National Technical Information Service
(NTIS) as PB-232 075).

Key Words: iodides, total dissolved solids, surface water (fresh).

Abstract:

Avian, amphibian, and fish embryos were given continuous treatment with inorganic mercury, methyl mercury, cadmium and lead, to determine the sensitivity of embryogenesis to metallic poisoning. All metals produced substantial degrees of lethality and/or gross anatomical anomalies at 10 ppb or less. Treatment with inorganic mercury at 10 ppb produced 100% kill of frog embryos. Chick and rainbow trout embryos suffered 10-20% lethality when exposed to 1 ppb of either inorganic or methyl mercury. Lead and cadmium at 1 ppb produced 24-32% lethality in chick embryos. No significant differences were observed in the embryopathic effects of inorganic or methyl mercury. Concerning the toxic effects of mercury, cadmium and lead, the 'embryonic stage' appears to constitute the critical 'sensitive link' in the vertebrate populations may be severely restricted (e.g., embryonic mortality) by such pollutants at trace levels which may not prove hazardous to adult animals.

Birge, W.J. and J.J. Just.

Sensitivity of Vertebrate Embryos to Heavy Metals as a Criterion of Water Quality. Phase II. Bioassay Procedures Using Developmental Stages as Test Organisms.

Kentucky Water Resources Institute, Lexington, March 1975. 41p. (Available from National Technical Information Service (NTIS) as PB-240 978).

Key Words: arsenic, cadmium, mercury, lead, zinc, fish.

Abstract:

Chick, amphibian, and fish embryos were evaluated as bioassay and bioindicator organisms. Test procedures were developed by which embryonic stages may be used in bioassay systems to evaluate the toxicity of particular metallic or metal-containing trace contaminants, and as bioindicators to monitor the quality of natural water resources. A bioassay technique was devised in which metallic toxicants were administered to chick embryos by 'needle tract' injection into the yolk sac. This provided more uniform distribution of test metals throughout the yolk mass than can be obtained by conventional yolk sac injection methods, and gave more sensitivity and uniformity of test results. Metals such as arsenic, cadmium, mercury, lead and zinc are easily detectable at a level of 1 ppb. An in vitro culture technique was developed by which embryos of aquatic vertebrates may be 'maintained' for bioassay and bioindicator purposes. Five test species were identified, suitable synthetic culture water was formulated, and culture monitoring procedures were determined.

Bishop, D.F., T.P. O'Farrell, and J.B. Stamberg.

Physical-Chemical Treatment of Municipal Wastewater.

JWPCF. 44(3):361-371. March 1972.

Key Words: BOD, COD, phosphates, suspended solids, total organic carbon, chemical treatment, adsorption/ion exchange.

Abstract:

Physical-chemical treatment consisting of two-stage lime precipitation with intermediate recarbonation, filtration, pH control, selective ion exchange, and carbon adsorption removed approximately 95 percent of the TOC, BOD, and COD, 97 percent of the SS, 98 percent of the total phosphorus, and 78 percent of the total nitrogen from the District of Columbia raw wastewater. The pollutant residuals for 6 months of treatment averaged 6 mg/l TOC, 5 mg/l BOD, 13 mg/l COD, 5 mg/l SS, 0.15 mg/l total phosphorus as P, and 4.6 mg/l of total nitrogen.

Bishop, D.F., T.P. O'Farrell, A.F. Cassel, and A.P. Pinto.

Physical-Chemical Treatment of Raw Municipal Wastewater.

EPA-670/2-73-070, U.S. Environmental Protection Agency,
Washington, D.C., Office of Research and Monitoring,
September 1973. 60p.

Key Words: BOD, COD, ammonia, nitrates, phosphates, suspended solids, chemical treatment, adsorption/ion exchange, chlorination.

Abstract:

Physical-chemical treatment of raw wastewater in a 50,000 to 100,000 gpd pilot plant consisted of two-stage lime precipitation with intermediate recarbonation, filtration, pH control, ion exchange or breakpoint chlorination for nitrogen removal and carbon adsorption. The complete system with ion exchange removed 98 percent of the phosphorus, 95 percent of the organics (COD) and 78 percent of the total nitrogen. With breakpoint chlorination, the complete system removed approximately 98 percent of the phosphorus, 94 percent of the organics (COD) and 86 percent of the total nitrogen.

Bishop, D.F., J.A. Heidman, and J.B. Stamberg.

Single-Stage Nitrification-Denitrification.

EPA-670/2-75-051, National Environmental Research Center, Cincinnati, Ohio. June 1975. 29p.

Key Words: ammonia, nitrates, nitrites, nitrification/denitrification.

Abstract:

The removal of 75 to 84 percent of nitrogen from primary wastewaters has recently been achieved in a single stage activated sludge process (30,000 to 50,000 gpd) at the EPA-DC pilot plant in Washington, D.C., without the use of supplemental organic carbon. The removal was achieved in a two pass biological reactor in which the dissolved oxygen concentration was varied from 0 to 2 to 3 mg/1. The air from the blower was applied on a 30-min cycle, first to one reactor pass then to the other pass. Mechanical mixers suspended the mixed liquor solids when the air was not applied to the pass. At an F/M ratio of 0.1 gm BOD_5/day/gm MLVSS, a mixed culture of carbonaceous (BOD_5 removal), nitrifying and denitrifying organisms developed and essentially complete nitrification was achieved. With the dissolved oxygen at 2 or above, the nitrification readily occurred. When the dissolved oxygen decreased to near zero, denitrification occurred.

Even if bulking limits winter operations, application of the dissolved oxygen cycle to existing extended aeration plants in warm weather reduce requirements to achieve nitrification and BOD_5 removal. The reduced air requirement potentially lowers conventional operating costs.

Bishop, D.F., J.A. Heidman, and J.B. Stamberg.

Single-Stage Nitrification-Denitrification.

JWPCF. 48(3) :520-532. March 1976.

Key Words: nitrates, nitrites, nitrification/denitrification, activated sludge.

Abstract:

The removal of 75 to 84 percent of nitrogen from primary wastewaters was achieved in a single-stage activated sludge process (30,000 to 50,000 gpd) at the EPA-DC pilot plant in Washington, D.C., without the use of supplemental organic carbon. The removal was achieved in a two-pass biological reactor in which the DO concentration varied from 0 to 2 to 3 mg/l. Even if bulking limits winter operations (in the winter bulking occurred in the reactor and required low overflow rates of 300 gpd/sq ft (12.2 m/day) to capture the solids in the clarifier) application of the DO cycle to existing extended aeration plants in warm weather reduces air requirements to achieve nitrification and BOD_5 removal. The reduced air requirement potentially lowered conventional operating costs and substantially increased the total nitrogen removal.

Bishop,D.F., L.S. Marshall, T.P. O'Farrell, R.B. Dean, B.O'Connor, R.A. Dobbs, S.H. Griggs, and R.V. Villiers.

Studies on Activated Carbon Treatment.

JWPCF. 39(2): 188-203. February 1967.

Key Words: synthetic/organics, adsorption/ion exchange.

Abstract:

The study of the effect of clarification on column treatment with granular activated carbon showed the following:

1. Intermittent operation of carbon columns reduces soluble organic materials in clarified bio-oxidized waste effluents to levels below one milligram per liter.

2. Carbon columns do a relatively poor job of removing turbidity and associated organic matter. A column of approximately 11 ft (3.35 m) is required to remove half of the turbidity.

3. Carbon columns do not remove some highly polar organic molecules.

4. Organic matter adsorbed on a carbon column can go septic, a condition that produces a breakthrough of turbidity and organic matter. Predisinfection of the feed might insure against such failure.

Studies on removal of organic material with powdered activated carbon led to the following conclusions:

1. Powdered carbon is capable of reducing the organic content of treated wastewater to two milligrams per liter or less if used with adequate clarification to remove colloids.

2. Carbons differ markedly in their ability to remove organic matter from water.

3. There is no simple test, not even surface-area determinations, that will predict accurately the relative efficiencies of carbons.

4. The adsorption of methylene blue or ABS correlates fairly well with the efficiency of carbon in a typical secondary waste effluent.

5. The phenol number is not a useful measure of the ability of a carbon to remove total organic matter from treated wastes.

Black, A.P., A.T. DuBose, and R.P. Vogh.

Physical-Chemical Treatment of Municipal Wastes by Recycled Magnesium Carbonate.

EPA/660/2-74-055, Gainesville, Florida, June 1974. 125p. (Available from National Technical Information Service (NTIS) as PB-239 326).

Key Words: BOD, COD, phosphates, total organic carbon, chemical treatment, influent characteristics, effluent characteristics.

Abstract:

The applicability to municipal wastes of the recently discovered magnesium carbonate-lime water treatment process has been investigated. A sixteen-month laboratory study was conducted and was followed by an eight-month pilot plant study. Four wastewaters with COD values varying from 200 to 1,500 mg/l were examined. Bench-scale coagulation studies designed to compare the effect of added $MgCO_3$ with treatment by lime only showed a 0%-30% greater reduction in effluent COD residuals. Color and turbidity reduction by the magnesium-plus-lime process averaged 50%-85% greater when compared to treatment by lime only. A series of 72-hour pilot plant runs was conducted with the magnesium precipitated increased after each three-day period. Effluent characteristics improved as the amount of magnesium precipitated was increased. Influent and filter effluent samples were collected every four hours and analyzed for COD, TOC, total phosphorus, alkalinity, hardness, calcium, and magnesium. Values for BOD were determined from composited samples.

Blanchard, D.C. and L. Syzdik.

Mechanism for the Water-to-Air Transfer and Concentration of Bacteria.

Science. 170:626-628. November 6, 1970.

Key Words: bacteria, air.

Abstract:
Air bubbles breaking at the air-water interface can remove bacteria that concentrate in the surface microlayer and eject the bacteria into the atmosphere. The bacterial concentrations (numbers per milliliter) in the drops ejected from the bubbles may, depending on drop size, be from 10 to 1000 times that of the water in which the bubbles burst.

Blatter, P.X.

Wet Air Oxidation at Levittown.

Water and Sewage Works. 117(2):32-34. February 1970.

Key Words: suspended solids, incineration.

Abstract:

Oxidized sludge is brown and has a uniform consistency. After cooling, there is practically no odor except when held close to the nose. The liquid portion separating from the oxidized sludge is a deep reddish brown and almost clear. There is no odor from the liquid portion after it has been cooled. We have not observed any detrimental effects from the amount of filtrate returned to the plant; conversely treatment plant performance has improved since Zimpro filtrate has replaced digested sludge filtrate returning to the treatment plant.

Sulfur, oxidized to sulfate, remains in the wet sludge and does not appear in the exhaust gas. Fly ash is totally absent because the oxidized sludge is in a water suspension. A catalyst oxidizes any organics in the exit gas, thereby eliminating the need for a wet scrubber; hence air pollution has been prevented.

The filter cake finds use as a mulch material having characteristics for this purpose superior to the best peat moss. The cake has an earthy odor, is non-toxic to plant growth and has been sterilized by the processing. The Lower Bucks County Joint Municipal Authority plans to install a second unit to replace existing digesters.

Boardman, G. and O.J. Sproul.

Protection of Viruses during Disinfection by Adsorption to Particulate Matter.

Presented at the 48th Annual Conference, Water Pollution Control Federation, Miami, Florida, October 1975.

Key Words: viruses, chlorination.

Abstract:

The objective of this work was to determine the protection offered to viruses while undergoing disinfection with chlorine by virtue of their adsorption to particles.

Booer, J.R.

The Behavior of Mercury Compounds in Soil.

Annals of Applied Biology. 31:340-359. May 1944.

Key Words: mercury, groundwater.

Abstract:

The uses of inorganic compounds of mercury for the control of plant pests is reviewed, and a summary of the relevant chemical and physical properties of the compounds concerned is given. On chemical evidence a working hypothesis is propounded showing that all compounds may be expected to decompose into metallic mercury.

Boring, J.R. III, W.T. Martin, and L.M. Elliot.

Isolation of _Salmonella_ _Typhi-Murium_ from Municipal Water, Riverside, California, 1965.

American Journal of Epidemiology. _93_(1):49-54. 1971.

Key Words: epidemiology, salmonella.

Abstract:

Salmonella typhi-murium phage type 2 was isolated from six different samples of the municipal water of Riverside, California, during an epidemic involving over 16,000 persons. Five isolations were made using the membrane filter technique and large volumes of water. One additional isolation was made by direct inoculation of water in enrichment medium. A sample containing water from all parts of the city was examined quantitatively; salmonellae were 10 times as numerous as _E. coli._

Bourquin, A.W.

Microbial-Malathion Interaction in Artifical Salt-Marsh Ecosystems.

EPA-660/3-75-035, Gulf Breeze Environmental Research Laboratory, Gulf Breeze, Florida, June 1975. 51p. (Available from National Technical Information Service (NTIS) as PB-246 251).

Key Words: pesticides, soil sterilants, surface water (marine).

Abstract:

Malathion is rapidly degraded _in vitro_ by salt-marsh bacteria to malathion-monocarboxylic acid, malathion-dicarboxylic acid and various phosphothionates as a result of carboxyesterase cleavage. In addition, some expected phosphatase activity produces desmethyl-malathion, phosphomono- or -dithionates, and various 4-carbon dicarboxylic acids, as well as corresponding ethyl esters.

In a simulated salt-marsh environment, malathion is degraded by the indigenous bacterial community. Numbers of bacteria capable of degrading malathion in the presence of additional nutrients increase in the sediments with increasing frequency of application and in the water column with the increasing level of application. Numbers of bacteria which degrade malathion as a sole carbon source appear to be linked to the level of malathion treatment in sediments and the frequency of malathion treatment in the water column. Malathion sole-carbon-degrading bacteria do not appear to play a significant role in the dissipation of malathion, comprising only about 10% of the portion of bacteria which degrades malathion. It is believed that due to increased frequency of treatment, increased numbers of malathion co-metabolizing bacteria catalyze a more rapid dissipation of the compound, resulting in less selection of the sole carbon degraders.

The disappearence of malathion in the salt-marsh environment is influenced by both chemical and biological degradation. Chemical hydrolysis increases with increasing temperature and salinity, but at temperatures below 26°C and salinities below 20 ⁰/oo, these mechanisms are of lesser importance than biological degradation.

Bouwer, H.

Land Treatment of Liquid Waste: The Hydrologic System.

In: Recycling Municipal Sludges and Effluents on Land; Proceedings of the Joint Conference, July 9-13, 1973. pp. 103-111.

Key Words: ponding/land application.

Abstract:

The hydrologic aspects of systems for applying liquid waste to land are basically covered by irrigation and drainage theory. Factors to be considered include (a) the design application or infiltration rates in relation to the hydraulic acceptance of the soil, the desired quality improvement of the water, and the intended longevity of the system, (b) the most appropriate system for applying the wastewater, and (c) the groundwater management below the receiving fields. While most irrigation and drainage principles are generally known, there is still need for additional research on many of these aspects. Because the performance of a land treatment system depends so much on the local conditions of soil, climate, and groundwater geology, local research and pilot systems should usually precede large-scale developments.

Additional research is needed to determine the effect of the application system itself on the hydraulic loading rate and the quality improvement of the wastewater as it moves through the soil. The loading rates and oxygen regimes for flooded and sprinkled soils are not the same, for example, and this may influence denitrification, immobilization of heavy metals, and other reactions. More research is needed on the optimum treatment of the wastewater before it is applied to the land. If the water is to be reused, the soil filtration process may not yield renovated water of sufficient quality at high loading rates. In that case, studies should be made to determine the optimum combination of treatment of the water before and after it has moved through the soil.

Bouwer, H.

Renovating Secondary Effluent by Groundwater Recharge with Infiltration Basins.

In: Conference On Recycling Treated Municipal Wastewater through Forest and Cropland. W.E. Sopper and L.T. Kardos, eds. EPA-660/2-74-003, Pennsylvania State University, University Park, Institute for Research on Land and Water Resources, March 1974. pp. 146-156.

Key Words: BOD, COD, ammonia, nitrates, nitrites, phosphates, fluorides, boron, copper, zinc, cadmium, lead, coliforms, ponding/land application, air, groundwater.

Abstract:

The Salt River Valley in central Arizona is changing from a predominantly agricultural to a predominantly urban valley. Groundwater currently supplies about one third of the municipal and agricultural needs in the area. The resulting depletion of the groundwater can be reduced if the sewage effluent produced by the increasing population can be reused. The principal contenders for the sewage effluent would be irrigated agriculture and recreation; unrestricted use of sewage effluent for such purposes requires tertiary treatment.

A pilot system in which effluent was treated with groundwater recharge, with spreading basins in the Salt River bed was installed in 1967. The studies showed that a full-scale operational system could be designed on the basis of a hydraulic loading of about 300 ft/yr. The effective transmissibility of the aquifer for recharge was evaluated by resistance network analog and horizontal flow theory. It was concluded that a large-scale operational system should yield renovated water that can be used for unrestricted irrigation, primary contact recreations, and certain industrial applications. Preliminary estimates indicate the total cost of putting the sewage effluent into the ground and pumping it up as renovated water with the system in the Salt River bed will be around $5 per acre foot.

Bouwer, H.

Use of the Earth's Crust for Treatment or Storage of Sewage Effluent and Other Waste Fluids.

CRC Critical Reviews in Environmental Control. pp. 111-130. March 1976.

Key Words: ammonia, BOD, nitrates, nitrites, phosphates, COD, total organic carbon, coliforms, fluorides, boron, viruses, groundwater, surface water (fresh).

Abstract:
This paper provides a general review of means of land disposal of either treated or untreated sewage wastes.

Bouwer, H., J.C. Lance, and M.S. Riggs.

High-Rate Land Treatment II: Water Quality and Economic Aspects of the Flushing Meadows Project.

JWPCF. 46(5):844-859. May 1974.

Key Words: ammonia, BOD, COD, nitrates, suspended solids, total dissolved solids, total organic carbon, boron, copper, zinc, coliforms, ponding/land application, groundwater.

Abstract:

Five years of experimental work on renovating secondary sewage effluent by groundwater recharge with rapid infiltration basins in the sandy and gravelly materials of the Salt River bed west of Phoenix, Arizona demonstrated that a high-quality renovated water suitable for unrestricted irrigation and recreation can be obtained with a rapid infiltration system in the Salt River bed. The cost of putting the effluent underground and pumping it up as renovated water in a large-scale system consisting of infiltration basins along both sides of the riverbed and wells in the center of the riverbed was estimated at about $5.3/acre-ft ($4.3/1,000 cu m). This is much less than the cost of equivalent in-plant tertiary treatment to produce a renovated water of similar quality.

Boyden, C.R.

Trace Element Content and Body Size in Mollusks.

Nature. 51:311-314. September 1974.

Key Words: cadmium, copper, iron, lead, nickel, zinc, shellfish.

Abstract:
This article relates concentration of heavy metals to body size in mollusks including uptake by the various species.

Boyden, C.R. and M.G. Romeril.

A Trace Metal Problem in Pond Oyster Culture.

Marine Pollution Bulletin. 5(5):74-78. May 1974.

Key Words: cadmium, copper, iron, lead, manganese, shellfish.

Abstract:

Analyses of waters, sediments, animals, and algae collected from a number of sites on the foreshore, at Hinkley Power Station, and the marine farm have led these researchers to conclude that the considerably elevated zinc and copper concentrations in oysters grown in ponds at the farm were due to accessories used within the ponds. Zinc, obviously in a readily available form, was almost certainly derived from the corrosion of galvanized zinc trays upon which the oysters were suspended within the pond. Increased copper on the other hand was due to the corrosion of the phosphor-bronze blades of the recirculating pump. This second assumption appears to have been confirmed since copper levels in fresh oysters placed in the pond in August 1972, after the pump had been removed, have remained normal. The pump blades also showed signs of considerable corrosion. Zinc trays are still in use, and this is reflected by the continuing high zinc content of the new oysters. Furthermore, throughout the period of sampling, the concentration of zinc within the oysters rose considerably whereas their copper content decreased. These trends are significant because prior to our initial sampling in September 1972, the oysters had been maintained within bags in the pond with the recirculating pump operative. It was at this time that the animals were transferred onto zinc trays and placed in an adjacent pond where recirculation was not taking place.

The metal loads in the water and sediments of the Severn estuary and cooling water from the power station would not appear to be the cause of high metal concentrations in oysters reared at the farm. Perhaps the most revealing aspect of this study is the magnitude of metal accumulation resulting from a seemingly small source of contamination. Bivalve molluscs are notorious in their ability to concentrate metals and this has been particularly apparent in our study. Other groups of animals (e.g. the Japanese prawn, _Penaeus japonicus_) which are also reared at Hinkley, accumulate metals to a much lesser degree.

It is obvious that considerable caution should be exercised with accessories used in rearing marine animals, especially molluscs. Even if concentrations in the animals do not constitute a public health hazard, there is always the risk of a direct toxic effect upon particularly susceptible species. Within the literature there are several instances of poisoning of trout by metals derived from hatchery accessories. Zinc in galvanized iron piping may be leached by acid waters while cadmium originating from a screen can be equally lethal. This feature is also of particular importance to oyster hatcheries, where it is recognized that brass and other copper-containing metals, as well as alloys of stainless steel should be eliminated from culture systems because of the susceptibility of bivalve larvae to metals in solution.

It should be stressed that the oysters discussed above were on-grown at Hinkley in a pilot study assessing the suitability of power station cooling water for oyster culture, and at no time were they available for public consumption.

Bradford, G.R.

Boron.

In: Diagnostic Criteria for Plants and Soils. H.D. Chapman, ed. Quality Printing Company, Abilene, Texas , 1973. pp. 33-61.

Key Words: boron, ponding/land application, land reclamation, groundwater, crops.

Abstract:

The author details plant criteria useful in diagnosing boron status giving visual symptoms of boron deficiency or excess, and lists boron-sensitive, boron-semitolerant, and boron-tolerant plants, as well as describing tissue analysis values. He also discusses soil criteria useful in diagnosing boron status-deficiency and excess and soil analysis values of significance, including total, water-extractable, and microbiologically available boron. He concludes with a discussion of boron deficiency and excess.

Bradford, R.R.

Nitrogen and Phosphorus Losses from Agronomy Plots in North Alabama.

EPA-660/2-74-003, Alabama Agricultural and Mechanical College, Normal, April 1974. 49p. (Available from National Technical Information Service (NTIS) as PB-235 931).

Key Words: ammonia, nitrates, nitrites, phosphates.

Abstract:

Nutrient relationships in agricultural situations are discussed in this report which is only marginally applicable to this study.

Bradshaw, J.S., E.L. Loveridge, K.P. Rippee, J.L. Peterson, D.A. White, J.R. Barton, and D.K. Fuhriman.

Seasonal Variations in Residues of Chlorinated Hydrocarbon Pesticides in the Water of the Utah Lake Drainage System - 1970 and 1971.

Pesticides Monitoring Journal. 6(3):166-170. December 1972.

Key Words: pesticides, DDT, DDE, chlorinated hydrocarbons, aldrin, surface water (fresh).

Abstract:

Definite surges of pesticides (1 ppb or more) enter Utah Lake three times per year - early spring, late spring, and fall, generally corresponding to the application times of pesticides by farmers in the area. The pesticides involved were mainly aldrin and BHC in the early spring; heptachlor (plus heptachlor epoxide) and methoxychlor in the late spring; and aldrin, heptachlor, and methoxychlor in the late fall. The fish samples collected from Utah Lake contained only small amounts of pesticides, the highest level being 956 ppb DDE.

Brasfeild, H.

Environmental Factors Correlated with Size of Bacterial Populations in a Polluted Stream.

Applied Microbiology. 24:349-352. February 1972.

Key Words: bacteria, coliforms, fecal streptocci, surface water (fresh).

Abstract:

Samples of water were taken from a polluted zone of the Gallinas River and analyzed as to numbers of total bacteria, coliforms, and fecal streptococci. Environmental factors measured were temperature, pH and concentrations of detergent, nitrate plus nitrite nitrogen, sulfate, chloride, bicarbonate and phosphate. Thirty-two observations were made from 12 March through 22 July, 1971. Stepwise multiple linear regression analyses of the data were carried out by computer to determine which of the environmental factors were significantly correlated with numbers of bacteria present. A multiple linear regression equation was constructed for each bacteriological parameter as a function of significant variables only. Log total bacteria was correlated positively with bicarbonate, phosphate, and detergent concentrations. Log coliforms was correlated positively with phosphate and sulfate concentrations and negatively with chloride concentration. Log fecal streptococci was correlated positively with bicarbonate and chloride concentrations.

Braswell, J.R. and A.W. Hoadley.

Recovery of _Escherichia_ _coli_ from Chlorinated Secondary Sewage.

Applied Microbiology. _28_:328-329. August 1974.

Key Words: _Escherichia_ _coli_, chlorination.

Abstract:

This publication discusses the destruction of _Escherichia_ _coli_ by chlorination as a function of residence time.

Brewer, R.F.

Fluorine.

In: Diagnostic Criteria for Plants and Soils. H.D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 180-196.

Key Words: fluorides, ponding/land application, land reclamation, groundwater, crops.

Abstract:

The element fluorine is widely distributed in nature and the author lists visual symptoms of fluorine excess, indicator plants for fluoride pollution and tissue analysis values. He also discusses fluorine in soils and soil minerals, the availability of soil fluorine to plants and the control of fluoride toxicity.

Brewer, R.F.

Lead.

In: Diagnostic Criteria for Plants and Soils. Homer D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 213-217.

Key Words: lead, ponding/land application, land reclamation, groundwater, crops.

Abstract:

Lead has not been shown to be essential to plant growth, although a few workers have reported apparent benefits from additions of lead in fertilizers. The author discusses the effects of lead on plants, plant criteria useful in diagnosing lead deficiencies and excesses and soil criteria useful in diagnosing lead status.

Brezenski, F.T. and R. Russomanno.

The Detection and Use of Salmonellae in Studying Polluted Tidal Estuaries.

JWPCF. 41(5):725-737. May 1969.

Key Words: epidemiology, salmonella, surface water(marine).

Abstract:

The article presents observations on the isolation, occurrence of salmonellae, and estimated densities of indicator bacteria in tidal waters and shellfish.

It also mentions the factors to be considered in the interpretation of salmonella data.

In the polluted tidal estuaries, they found the relatively low percentage recovery of salmonella at the 1 to 200 fecal coliform on Staten Island.

Brezenski, F.T., R. Russomanno, and P. DeFalco.

The Occurrence of Salmonella and Shigella in Post-Chlorinated and Non-Chlorinated Sewage Effluents and Receiving Waters.

Health Laboratory Science. 2(1):40-47. January 1965.

Key Words: epidemiology, salmonella, shigella, surface water (fresh).

Abstract:

The effect of effluent chlorination on bacterial populations in Raritan Bay waters was studied. The phase reported herein involved the effects of post-chlorination on sewage treatment plant effluent with respect to salmonella and shigella Four sewage treatment plant effluents and the tidal portion of the Raritan River, affected by 3 of the plants, were studied. The chlorinated effluents and river samples did not show the presence of salmonella or shigella during the 7-mo. study. After post-chlorination of effluents was discontinued, members of the salmonella group were isolated from 2 of the 4 effluents. Salmonella was also isolated from the Raritan River during the non-chlorination period. After chlorination was resumed, the effluents were analyzed for a period of 4 weeks and all of the samples were negative for these pathogens. Samples taken from the Raritan River for a period of 15 wk. also failed to show the presence of these enteric organisms.

To demonstrate the occurrence of these pathogens in untreated sewage, 6 outfalls emanating from Staten Island and affecting Raritan Bay waters were studied. Salmonellae were isolated from 5 of the 6 outfalls.

Brinska, G.A.

Sludge Disposal by Incineration at Alcosan.

In: Municipal Sludge Management; Proceedings of the National Conference on Municipal Sludge Management, 1974. pp. 157-161.

Key Words: BOD, suspended solids, activated sludge.

Abstract:

What to do with the solids from constantly escalating treatment procedures is rapidly becoming a major problem in operating a modern wastewater treatment plant. Pittsburg elected to incinerate and in doing so eliminated its sludge disposal problems. To incinerate just to reduce the overall quantity is not the answer. Solid waste (garbage) is also a problem. The answer may be the incineration of a mixture of sewage solids and solid waste materials with the generation of steam as a final product.

Britton, J., J. Peterson, D. Zeng, and C. Lue-Hing.

Big Creek Coliform Study at Fulton County, Illinois.

Metropolitan Sanitary District of Greater Chicago, 1973.

Key Words: *Escherichia coli*, fecal streptococci, coliforms, surface water (fresh), crops.

Abstract:

This paper reports on original research enumerating coliform, fecal coliforms, and fecal streptococci found entering Illinois water supply canals from livestock grazing areas. Samples were taken from six stations, three times per day, three days per week for four weeks and analyzed for total coliform, fecal coliform, and fecal streptococcus as indicators of contamination. No evidence of high coliform populations were found in the water basin serving the area which received liquid fertilizer in 1972.

Broadbent, F.E.

Factors Affecting Nitrification-Denitrification in Soils.

In: Conference on Recycling Treated Municipal Wastewater through Forest and Cropland. W.E. Sopper and L.T. Kardos, eds. EPA-660/2-74-003, Pennsylvania State University, University Park, Institute for Research on Land and Water Resources, March 1974. pp. 204-214.

Key Words: ammonia, nitrates, land reclamation.

Abstract:

Disappearance of nitrate near the water table was associated with decreases in redox potential oxygen content of the soil solution, and oxygen levels in the soil atmosphere. This paper is a good review of nitrification-denitrification processes in soils.

Brodsky, A., J. Procházka, and H. Vydrová.

Classification of Organic Pollution in Surface Waters.

JAWWA. 62(6):386-390. June 1970.

Key Words: synthetics/organics, surface water (fresh), surface water (marine).

Abstract:

Oden's classification of humic substances present in natural waters was compared with the elution patterns of these materials in Sephadex. The elution patterns of humic groups in the sense of Oden's systematics were shown using Sephadex G 75 grade.

Basic peat extracts were prepared using two different manners of preparation in regard to duration of extraction period, buffer capacity and ion strengths of extraction agents. Both differed in the ratio of the groups, but were identical regardless of origin.

Different preparation procedures were examined to obtain group standards. The characters of substances were preserved in the best way, since they were used in concentrated solution gained by vacuum evaporation. Isolation procedures, either precipitation or dissolving of precipitate followed by considerable changes in pH value or alcohol extractions influenced the proportions of fractions with smaller size particles. Drying of samples had a still more disturbing effect. As far as it was necessary to use a procedure with a great change of pH in the isolation, work proceeded with samples that "aged" during 12 days after the final neutralization. The elution patterns of samples thus treated showed the greatest similarity to elution patterns of those samples, which had not been subjected to any preparative procedure but vacuum evaporation.

The studies of gel filtration on Sephadex showed that it is possible to separate several fractions from humic substances using the G 75 grade without having any substantial portions of substances that were not displaced from the column. Under standardized conditions the elution curves may be

used for qualitative - and, to a certain extent quantitative - estimation of individual groups of humic substance participation in the sample.

Elution patterns that give the picture of organic matter in natural water from the point of view of particle size showed that the criteria for the classification of humic matter fractions with regard to their chemical properties (in the sense of Oden's classification) coincide only to a limited extent with the conception of particle size distribution.

Brown, J.R. and L.Y. Chow.

Comparative Study of DDT and Its Derivatives in Human Blood Samples in Norfolk County and Holland Marsh, Ontario.

Bulletin of Environmental Contamination and Toxicology. 13(4):483-488. 1975.

Key Words: DDT, epidemiology.

Abstract:

DDT concentrations of adipose tissue and blood from accident victims was studied. Blood samples from 52 persons who had been engaged in the agricultural application of DDT in Norfolk County, and 315 samples of blood from residents of Holland Marsh, Canada are also discussed.

Brown, R.E.

Significance of Trace Metals and Nitrates in Sludge Soils.

JWPCF. 47(12):2863-2875. December 1975.

Key Words: cadmium, chromium, copper, lead, mercury, nickel, zinc, agriculture, groundwater, surface water (fresh), crops.

Abstract:

The ability of a plant to absorb metal from a compound depends on factors other than the solubility of the metal compound in water.

Plant uptake of metals from soils depends on the portion of soil metal called plant-available metal rather than the total metal content of soils.

The potential for nitrate pollution of water in a given year depends on the accumulated organic nitrogen in the soil from previous sludge applications as well as the nitrogen in the sludge application during the year under consideration.

These concepts and additional data will be used to show that there is a substantial potential for damage to the productivity of soils that are fertilized with wastewater sludge if no restrictions are made on the metal accumulation in the soil. Even more important, the voids that now exist in the available knowledge of the soil chemistry of metals such as zinc, copper, and nickel will be outlined. The nitrogen discussion centers on the selection of sludge application rates that will not result in significant nitrate pollution of ground or surface waters.

Brown, T.S., J.F. Malina, Jr., and B.D. Moore.

Virus Removal by Diatomaceous-Earth Filtration - Part 1.

JAWWA. 66(2):98-102. February 1974.

Key Words: viruses, filtration.

Abstract:

The removal of viruses by diatomaceous-earth filtration is possible; however, greater than 99 percent removal was possible only with filter aid D and with filter aid A and a pretreatment consisting of 0.081 mg/l of the polyelectrolyte 1. These data are based on an operating period of 2 hr.

The inactivation of the T2 bacteriophage was initiated in the plastic feed tank. Therefore, the removal efficiencies presented in the report were calculated to represent only that removal due to attachment to the diatomaceous earth and filtration through the filter aid.

The technique with the insoluble polyelectrolyte required a modification for use with dechlorinated tap water. The optimal T2 recovery required attachment at pH 6.25 and desorption at pH 9.55.

The procedure for coating the filter aid with inorganic coagulants affects the efficiency of T2 virus removal.

No T2 virus was observed in the filtrate after 12 hr of operation of the filter aid A system with a pretreatment of 0.07 mg/l of polyelectrolyte 1.

Polyelectrolyte 1 did not exhibit any viricidal effects on T2 at a concentration of 0.081 mg/l after 4 hr.

Brown, T.S., J.F. Malina, Jr., and B.D. Moore.

Virus Removal by Diatomaceous Earth Filtration - Part 2.

JAWWA. 66:735-738. December 1974.

Key Words: coliphage T_2, polio virus, filtration.

Abstract:
Removals of >98% were achieved here; in most cases 100% removal was achieved.

Brown, T.S., J.F. Malina, Jr., B.D. Moore, and B.P. Sagik:

Virus Removal by Diatomaceous Earth Filtration.

In: Virus Survival in Water and Wastewater Systems. J.F. Malina, Jr., and B.P. Sagik, eds. University of Texas at Austin, Center for Research in Water Resources, 1974. pp. 129-144.

Key Words: viruses, chlorination.

Abstract:

Greater than 98 percent removal of the model viruses, phage T2, and poliovirus was obtained using Hyflo coated with either ferric hydrate or C-31 polymer. However, the procedure used to coat the diatomite can significantly influence its ability to remove viruses. Pretreatment of the feed with C-31 polymer in conjunction with Hyflo resulted in reduction of the virus titer to less than the detectable limits of the analytical procedure used. Uncoated diatomite removed greater than 90 percent initially, followed by slowly diminishing efficiencies. Capacity for removal of poliovirus with uncoated diatomite was lower than for phage T2.

The insoluble polyelectrolyte technique using PE-60 required modification for use with dechlorinated tapwater. The optimal phage T2 recovery occurred with attachment at pH = 6.25 and elution at Ph = 9.55. For polio virus, optimal recovery occurred with attachment at pH = 6.0. The virus was eluted at pH = 9.0 to avoid inactivation problems.

Changing filtration parameters, flow rate and filter aid grade did not significantly affect the removal of viruses. However, pH significantly reduced removal when the pH of the water system was lowered from pH = 9.5 to pH = 6.5.

Virus removal appeared to occur during passage through the filter cake of uncoated diatomite. The same virus removals were obtained with or without body feed; therefore, body feed requirements would thus be set by requirements for maintenance of cake porosity as is currently the practice.

The C-31 polymer did not exhibit virucidal effects on either of the model viruses under conditions studied.

Browning, G.E. and J.O. Mankin.

Gastroenteritis Epidemic Owing to Sewage Contamination of Public Water Supply.

JAWWA. 81(11):1465-1470. November 1966.

Key Words: coliforms, crops, groundwater, drinking and recreational water.

Abstract:

In August 1965, a waterborne epidemic of enteritis occurred in Madera, Calif. There is considerable evidence that the epidemic was a result of sewage contamination of the city's water supply through one of its wells. The exact evidence includes the high coliform counts in the distribution system and the water from Well 14. The inexact evidence includes the demonstration that water could flow from the sewage-irrigated field into Well 14. Medical data supported the conclusions regarding the contamination.

In recent years, waterborne epidemics have become rare. This one seems to have occurred as a result of the combination of several circumstances, some of which are unusual:

1. Irrigation of the field with undisinfected sewage.

2. Presence of a gopher hole leading in a particular direction.

3. Connection between the valve excavation and the well pit.

4. Presence in the pit of openings into the well casing.

Measures have been taken to prevent future recurrences.

Browning, J.E.

New Water Cleanup Roles for Powdered Activated Carbon.

Chemical Engineering. 79:36-48. February 21, 1972.

Key Words: BOD, COD, adsorption/ion exchange.

Abstract:
Removals of COD and BOD are discussed using powdered activated carbon.

Bruland, K.W., K. Bertine, M. Koide, and E.D. Goldberg.

History of Metal Pollution in Southern California Coastal Zone.

Environmental Science and Technology. 8:425-432. May 1974.

Key Words: cadmium, chromium, cobalt, copper, lead, zinc, surface water (marine).

Abstract:

This paper investigates what elements are being mobilized to coastal waters and subsequently to the sediments. It was estimated that sewer discharges have their least effect upon iron, cobalt, and manganese. For these elements, the natural concentrations appear to be several times those associated with waste materials.

Brungs, W.A.

Effects of Residual Chlorine on Aquatic Life.

JWPCF. 45(10):2180-2193. October 1973.

Key Words: synthetic/organics, chlorination.

Abstract:

1. Tests of residual chlorine toxicity should be conducted with continuous-flow bioassay procedures and the most precise, sensitive, and appropriate analytical method for determining free and combined residual chlorine.

2. Environmental variables do not appear to affect residual chlorine toxicity significantly, although at low pH, toxicity may be increased as the result of the greater proportion of free chlorine present.

3. Trout, salmon, and some fish-food organisms are more sensitive than warm-water fish, snails, and crayfish.

4. Chronic toxicity effects on growth and reproduction occur at much lower concentrations than acutely lethal concentrations.

5. Most of the lethal effects of residual chlorine occur within 12 to 24 hr. Lethal effects of free chlorine are more rapid and occur at lower concentrations than those of chloramines.

6. Chlorination of wastewater results in a variety of chlorinated compounds in addition to chloramines. This aspect needs much greater research emphasis.

7. Residual chlorine persists for periods longer than the few minutes or hours indicated by some authorities.

8. Dechlorination with sodium bisulfite, sodium thiosulfate, and sulfur dioxide, or certain other compounds, greatly reduces or eliminates toxicity caused by residual chlorine. The potential chronic toxicity resulting from such additional treatment requires further research.

9. In areas receiving wastes treated continuously with chlorine, total residual chlorine should not exceed 0.01 mg/l for the protection of more resistant organisms only, or exceed 0.002 mg/l for the protection of most aquatic organisms.

10. In areas receiving intermittently chlorinated wastes, total residual chlorine should not exceed 0.2 mg/l for a period of 2 hr/day for more resistant species of fish or exceed 0.04 mg/l for a period of 2 hr/day for trout and salmon. If free chlorine persists, total residual chlorine should not exceed 0.01 mg/l for a period of 30 min/day for areas with populations of trout and salmon.

11. Substitutes for chlorination of wastewaters or cooling waters should be used whenever feasible, but only after adequate, acute and chronic toxicity studies have been made to determine the potential environmental impact of the substitutes. Their efficacy as adequate disinfectants must be verified.

Brunner, D.R. and O.J. Sproul.

Virus Inactivation during Phosphate Precipitation.

Journal of the Sanitary Engineering Division, ASCE. 96(SA2):365-379. April 1970.

Key Words: polio virus, viruses , chemical treatment.

Abstract:

Several statements may be made based on the data obtained in this study:

1. Virus particles are removed in great numbers by precipitation of phosphate with either calcium or aluminum in distilled water-phosphate media or domestic wastewater treatment plant effluent.

2. In distilled water and domestic wastewater treatment plant effluent solutions, precipitation with aluminum at pH 5.0 at $Al:PO_4 = 1.0$ effected 90% virus inactivation when 24 mg per 1 PO_4 was removed and 98% poliovirus inactivation when 30 mg per 1 PO_4 was precipitated.

3. In distilled water, treatment with calcium at pH 11.0 effected a 97% virus inactivation when 37 mg per 1 PO_4 was precipitated and in domestic wastewater treatment plant effluent calcium treatment effected 94% virus inactivation when 44 mg per 1 PO_4 was precipitated.

4. Removals of viruses by these two phosphate reduction processes may be predicted by use of a Freundlich isotherm.

5. Poliovirus removals are responsive to the hydrogen ion concentration in each process.

6. The sludge from such phosphate reduction processes presents potential health hazards.

7. Alum treatment of wastewaters for phosphate removal will remove more viruses than lime treatment of a comparable wastewater.

Bryan, E.H.

Concentrations of Lead in Urban Stormwater.

JWPCF. 46(10):2419-2421. November 1974.

Key Words: lead, combined municipal and/or storm systems.

Abstract:

Lead will reach the treatment plant through stormwater runoff in combined systems. The lead concentration in the Durham study ranged from an observed minimum of less than 0.10 mg/l (lower limit of detection for the procedure used) to a maximum value of 12.6 mg/l. The vast majority of all lead concentrations observed did not exceed 1.5 mg/l.

The earlier observation that resulted in this originally unplanned study of lead in urban stormwater (apparent toxicity influencing the BOD determination) was not supported by subsequent observations. The lead was associated with suspended solids and had no apparent effect on BOD. The original observed toxicity effect was attributed to possible presence of some heavy metals in discharges to the stormwater drainage channels from industrial sources and automobile service stations upstream from the sampling location.

Bryan, F.L.

Diseases Transmitted by Foods Contaminated by Wastewater.

In: Wastewater Use in the Production of Food and Fiber -- Proceedings. EPA-660/2-74-041, U.S. Environmental Protection Agency, Cincinnati, Ohio, Office of Research and Development, June 1974. pp. 16-45.

Key Words: coxsackie virus, poliovirus, salmonella, shigella, *Vibrio cholerae*, parasitic worms, virus, coliforms, bacteria, gravity separators, activated sludge, filtration, crops, livestock, food processing, groundwater, fish, shellfish, trickling filters, ponding/land application, chlorination, anaerobic digestion.

Abstract:

The routes of transmission of pathogenic organisms in wastewater through food to man are discussed. Past disease outbreaks are the agents listed. The survival, in wastwater treatment processes, of organisms is discussed.

Bryan, G.W.

The Occurrence and Seasonal Variation of Trace Metals in the Scallops Pecten maximus and Chlamys opercularis.

Marine Biological Association of the United Kingdom Journal. 53:145-166. February 1973.

Key Words: cadmium, chromium, cobalt, copper, iron, lead, nickel, zinc, shellfish.

Abstract:

A comparison has been made between the concentrations of eleven trace metals in the tissues of two species of scallops, Pecten maximus (L.) and Chlamys opercularis (L.), collected from the same area of the English Channel. Although there was considerable variation between individual animals, the mean concentrations of Ag, Co, Cr, Cu, Mn, Ni, Pb and Zn were higher in the whole body of chlamys than in pecten but concentrations of Al, Cd and Fe were lower. In both species, seasonal changes in the concentrations of Co, Cu, Fe, Mn, Ni, Pb and Zn were observed and, in general, the highest values were found in the autumn and winter months. These changes may be related to food supply, since concentrations were generally highest when phytoplankton productivity was low and tended to fall in the spring as productivity increased rapidly to its annual peak. Despite problems arising from individual and seasonal variation, the kidneys and digestive gland of scallops appear to have potential as biological indicators of trace metals.

The results obtained for pecten and chlamys are compared with those in the literature for species from the family Pectinidae.

Bryan, J.A.

An Outbreak of Hepatitis-A Associated with Recreational Lake Water.

American Journal of Epidemiology. 99:145-154. February 1974.

Key Words: hepatitis virus, surface water (fresh), air.

Abstract:

In a 15-day period in September 1969, 14 cases of viral hepatitis type A developed in members of a Boy Scout troop who had been camping on an island in a lake recreation area approximately four weeks earlier. The clustering of cases by onset date over a short time interval, the appearance of cases only among those troop members attending the campout, the absence of known prior exposure to hepatitis-A and the absence of hepatitis-B antigen in all but one of the cases, suggested a common-source exposure to hepatitis-A virus. Raw lake water, which was grossly contaminated and inadvertently consumed by many campers,was associated with a statistically significant risk of hepatitis-A. Since use of recreational waters continues to be a very popular pastime, physicians should be alert to the possibilities that acquisition of hepatitis-A can occasionally result from such activities.

Buelow, R.W. and G. Walton.

Bacteriological Quality vs. Residual Chlorine.

JAWWA. 63(1):28-35. January 1971.

Key Words: coliforms, chlorination, effluent characteristics.

Abstract:

From the data presented in this paper, the following conclusions may be drawn:

1. A change from combined to free chlorine residual in Cincinnati, Ohio, and an increase in residual concentration in February 1969 greatly reduced the monthly average coliform counts.

2. In general, the probability of finding coliform bacteria in a distribution system sample decreases as the residual chlorine concentration of the water increases. The results of the National Community Water Supply Survey conducted by the Cincinnati Bureau of Water Hygiene specifically showed that in chlorinated water supplies a chlorine residual must be maintained throughout the distribution system in order to have confidence that disinfection by chlorination has been accomplished.

3. The finding of coliform organisms in some distribution system samples, when none were detected in the raw water, indicates the need for continuous disinfection of all supplies to ensure the delivery of the highest possible bacteriological quality water to the consumer at all times.

4. The data in this paper support the suggestion that a majority of the bacteriological samples should be taken in known problem areas, e.g., reservoirs, dead-ends, and the periphery of the systems, etc., and that many of the bacteriological samples currently collected could be eliminated provided chlorine residual can be shown to be present throughout a distribution system.

Buelow, R.W., K.L. Kropp, J. Withered, and J.M. Symons.

Nitrate Removal by Anion-Exchange Resins.

JAWWA. 67(9):528-534. September 1975.

Key Words: ammonia, nitrates, nitrites, adsorption/ ion exchange, influent characteristics, effluent characteristics.

Abstract:
Based on the data collected during this study, the following conclusions can be made:

1. High concentrations of nitrates in water are not necessarily associated with any other mineral characteristic of the water.

2. The anion selectivity of ion-exchange resins changes with substantial changes in the ion concentrations in the water.

3. Typical strong-base anion-exchange resins are more selective for sulfates than nitrates under normal conditions.

4. Other anions in water compete with nitrates for ion-exchange sites.

5. Other substances in water interfere with nitrate removal using a strong anion-exchange resin.

    a. Silica reduces the nitrate-removal capacity of the resin but does not replace the nitrate in large amounts as an exchanged ion.

    b. Iron precipitates reduce nitrate removal, cake the resin, and require special treatment to be removed from the resin.

6. The cost of salt to regenerate the resin used for nitrate removal by ion exchange is a significant part of the cost of the process.

7. To evaluate the nitrate removal efficiencies of ion exchange accurately for a specific water, trials should be run with the water to be treated, rather than with simulated water.

8. If the need for nitrate removal from drinking water becomes more urgent and widespread, better regeneration processes must be developed. A change in the regenerants used could lessen both cost and waste disposal problems. Weak anion-exchange resins are also worthy of study.

Buhler, D.R., M.E. Rasmusson, and H.S. Nakave.

Occurrence of Hexachlorophene and Pentachlorophenol in Sewage and Water.

Environmental Science and Technology. 7(10):929-934. October 1973.

Key Words: drinking and recreational water, surface water (fresh).

Abstract:

Concentrations of hexachlorophene (HCP) and pentachlorophenol (PCP) in sewage and water samples have been analyzed by gas chromatography. HCP and PCP levels in 24-hr composite samples of sewage influent collected simultaneously from three Oregon cities ranged between 20-31 ppb and 1-5 ppb, respectively. Composite effluent values from these same sewage treatment plants were 6-12 ppb HCP and 1-4 ppb PCP, reflecting a 60-70% removal of HCP and a 4-28% removal of PCP. Analyses of daily and hourly water samples from the Willamette River collected just upstream from the city of Corvallis, Oregon, showed that HCP and PCP were present in river water in concentrations varying between 0.01-0.1 ppb and 0.10-0.70 ppb, respectively. Conventional processing of raw Willamette River water at the Corvallis Taylor water treatment plant removed about 60% of the HCP and PCP originally present in the water leaving about 40% of these chlorophenols in the finished drinking water. Identifications of HCP and PCP in sewage effluent and influent, Willamette River water and treated drinking water were confirmed by mass spectrometry.

Bunch, R.L., E.F. Barth, and M.B. Ettinger.

Organic Materials in Secondary Effluents.

JWPCF. 33(2):122-126. February 1961.

Key Words: COD, synthetic/organics, effluent characteristics.

Abstract:

A sufficient number of samples has not been examined to make firm conclusions concerning the nature of the constituents. However, from the data on hand, these studies on secondary effluents indicate the following trends:

1. The suspended solids accounted for 20 to 30 percent of the total COD of the effluents.

2. More than one-half of the ether extractable matter falls in the strong acid classification.

3. The majority of the constituents giving COD are dialyzable, but about 40 percent of the material is indicated to be of high molecular weight because it resists dialysis.

4. The ratio of volatiles to COD, corrected for chlorides, is approximately 1.5.

5. The ratio of constituents identified to volatiles is approximately 0.20.

6. The ratio of COD, corrected for chlorides, to constituents identified is approximately 3.0.

Burm, R.J. and R.D. Vaughan.

Bacteriological Comparison between Combined and Separate Sewer Discharges in Southeastern Michigan.

JWPCF. 28(3):400-409. March 1966.

Key Words: fecal streptococci, coliforms,
combined municipal/storm systems.

Abstract:

Total coliform densities in the overflow from combined sewers many times approach densities found in raw wastewater; those in the runoff from separate storm sewers are approximately one tenth of those in combined sewers. Fecal coliform densities in combined sewer overflows approach 100 percent of the total coliforms on individual samples but rarely more than 20 percent of the total coliform densities in a separate storm sewer installation. Fecal streptococcus densities are at remarkably equal levels in both types of sewer systems. Total coliform and fecal coliform densities show significant increases in magnitude during the warmer summer months, but the fecal streptococcus counts fail to show this pattern. Fecal streptococcus densities from a separate storm sewer system are generally equal to or greater than the fecal coliform counts.

Burnham, A.K., G.V. Calder, J.S. Fritz, G.A. Junk, H.J. Svec, and R. Vick.

Trace Organics in Water: Their Isolation and Identification.

JAWWA. 65(11):722-725. November 1973.

Key Words: synthetic/organics, groundwater, drinking and recreational water.

Abstract:

Water from certain wells supplying the city of Ames, Iowa, has had a bad taste and odor for many years. The probable source of contamination is a pit used for the disposal of coal-tar residues from a coal-gas plant that operated in the city during the 1920's. Apparently, the hydrocarbon residues were leached from the tar and transported into the aquifer.

Burns, D.E. and G.L. Shell.

Carbon Treatment of a Municipal Wastewater.

JWPCF. 46(1):148-164. January 1974.

Key Words: suspended solids, BOD, adsorption / ion exchange.

Abstract:

The results of this pilot plant study indicated that a chemical-powdered carbon treatment system can produce a high degree of treatment of a municipal wastewater. Typical effluent quality is graphically depicted. The run numbers in these figures refer to the chemical used (such as L for lime) and the carbon run associated with that chemical.

Results of an economic analysis indicated that alum treatment followed by two-stage, countercurrent carbon contacting with 75 mg/l dosage would cost \$0.183/1,000 gal (\$0.048/cu m). This includes \$0.004/1,000 gal (\$0.001/cu m) for chlorination of plant effluent with 5 mg/l Cl_2. The predicted plant effluent quality would be considerably better than a secondary biological treatment effluent for all parameters, but especially with respect to phosphorus and ss. It is doubtful whether secondary biological treatment followed by tertiary treatment for phosphorus removal could be accomplished for less than \$0.183/1,000 gal (\$0.048/cu m).

As the technology of powdered carbon regeneration develops to a fine degree, a more rigorous evaluation of the economic applicability of powdered carbon treatment systems will be possible. When this occurs, it is strongly suggested that powdered carbon systems will become a viable economic alternative to currently available treatment approaches for many wastes.

Burns, R.W. and O.J. Sproul.

Virucidal Effects of Chlorine in Wastewater.

JWPCF. 39(11):1834-1849. November 1967.

Key Words: viruses, chlorination.

Abstract:

The article concludes the following:

1. Amperometric chlorine residuals provided a consistent indication of the virucidal capacity of chlorinated settled wastewater and trickling filter effluent samples. A 99-percent inactivation of the T2 virus used was obtained with 2.7 mg/l of amperometric residual.

2. Orthotolidine arsenite chlorine residuals showed no direct correlation to the virus inactivation produced in the samples tested.

3. The coliform test was found not to be a reliable indication of the effectiveness of virus chlorination.

4. Less stock chlorine was required to inactivate the T2 phage in settled wastewater samples than in trickling filter effluent samples.

5. The inactivation of virus in the effluents tested did not follow Chick's Law of disinfection.

6. The time of contact was found to be more important than chlorine dosage for virus inactivation in excess of 90 percent for the wastes tested.

Burrows, W.D. and P.A. Krenkel.

Studies on Uptake and Loss of Methylmercury-203 by Bluegills (Lepomis macrochirus Raf).

Environmental Science and Technology. 7(13):1127-1130. December 1973.

Key Words: mercury, fish.

Abstract:
The uptake of methylmercury-203 directly from water by bluegills was found to be nearly constant after five days at about 20% per gram of fish per liter of water. Transferred to mercury-free water at 24°C, bluegills exhibited a rapid loss of about 40% of the mercury, followed by a slow loss with a half-time of about five months. Mercury levels in the liver and kidneys were two to seven times higher than whole fish levels, but there was no discernible trend in this ratio with time. The proportion of mercury present as methylmercury in the whole fish remained at 73 ± 10% throughout the course of the experiment. The proportion of methylmercury in the liver and kidneys, however, fell rapidly in the first few weeks after exposure, ultimately leveling off at about 10%. This suggests that biochemical demethylation is taking place in these organs.

Butler, P.A.

Organochlorine Residues in Estuarine Mollusks,
1965-72 -- National Pesticide Monitoring Program.

Pesticides Monitoring Journal. 6(4):238-246. March 1973.

Key Words: DDT, endrin, chlorinated hydrocarbons, shellfish.

Abstract:

This paper describes the development of the national program for monitoring estuarine mollusks in 15 coastal states and reports the findings for the period 1965-72. The report is presented in two parts: Part I. General Summary and Conclusions, and Part II. Residue Data - Individual Analyses of the 8,095 samples for 15 persistent organo-chlorine compounds showed that DDT residues were ubiquitous; the maximum DDT residue detected was 5.39 ppm. Dieldrin was the second most commonly detected compound with a maximum residue of 0.23 ppm. Endrin, mirex, toxaphene, and polychlorinated biphenyls were found only occasionally. Results indicate a clearly defined trend towards decreased levels of DDT residues, beginning in 1969-70. At no time were residues observed of such a magnitude as to imply damage to mollusks; however, residues were large enough to pose a threat to other elements of the biota through the processes of recycling and magnification.

Butler, R.G., G.T. Orlob, and P.H. McGaughey.

Underground Movement of Bacterial and Chemical Pollutants

JAWWA. 46(2):98-111. February 1954.

Key Words: *Escherichia coli*, bacteria, air, direct contact, groundwater.

Abstract:

The movement of bacterial and chemical pollutants with water percolating through soil above the ground water table has been studied somewhat more extensively than the travel of pollution with ground water movement. This article reports on the results of field and pilot scale studies being conducted by the University of California Sanitary Engineering Research Laboratories on soils continuously spread with settled sewage or sewage treatment plant final effluent, and on underground recharge.

Butterworth, J., P. Lester, and G. Nickless.

Distribution of Heavy Metals in the Severn Estuary.

Marine Pollution Bulletin. 3(5):72-74. May 1972.

Key Words: zinc, lead, cadmium, air, surface water (marine).

Abstract:
There has been considerable agitation recently about heavy metal pollution in the Bristol Channel and Severn Estuary and on land around Bristol. Concentrations of zinc, cadmium, and lead in water, sediments, seaweeds, and shore animals are recorded from a number of sites on the southern shore of the estuary. Contamination is detectable ninety miles downstream of Avonmonth where the highest concentrations of these heavy metals are found.

Cabelli, V.J. and W.P. Heffernan.

Accumulation of *Escherichia coli* by the Northern Quahaug.

Applied Microbiology. *19*(2):239-244. February 1970.

Key Words: epidemiology, *Escherichia coli*, shellfish.

Abstract:

The uptake of *Escherichia coli* by the quahaug, *Mercenaria mercenaria*, was studied to obtain an insight into the environmental parameters significant to the accumulation of bacterial pathogens by shellfish growing in polluted waters and into the kinetics of the uptake process. Experimental uptake was achieved by placing the animals in a flowing water system in which the contamination level of the water and its temperature and salinity could be controlled. Data from periodic assays of individual animals suggested that accumulation of the bacteria by the quahaug proceeds to an equilibrium level which is a function of *E. coli* content of the water and its overall particulate matter. Accumulation takes place in the digestive gland and, to a lesser extent, in the siphon of the animal.

Cabelli, V.J. and W.P. Heffernan.

Elimination of Bacteria by the Soft Shell Clam,
Mya arenaria.

Journal of the Fisheries Research Board of Canada.
27:1579-1586. 1970.

Key Words: coliforms, bacteria, shellfish, fish.

Abstract:

Factors significant to the uptake and elimination of coliform bacteria by the soft shell clam, Mya arenaria, were investigated. Uptake kinetics resembling those in the northern quahaug suggest that a steady state exists in functioning animals wherein the number of organisms taken in and eliminated are in balance. In contrast to the quahaug, most of the animals accumulate the organisms very shortly after being placed in the environmental water. The lower limits on the temperature, salinity, and flow rate of the environmental water for acceptable elimination (depuration) were about 10 C, 20 o/oo, and 7 ml/min per animal respectively. In the feasibility study for a flow-through depuration system using naturally polluted animals, consistently good elimination to very low elevated temperature (ET) coliform levels was observed if the initial level of contamination did not exceed about 2000 ET coliforms per 100 g. Results comparable with those in the flow-through system were obtained in a recirculating depuration system, thereby indicating the feasibility of the recirculating depuration system for the elimination of coliforms in marginally polluted animals.

Cabelli, V.J., M.A. Levin, A.P. Dufour, and L.J. McCabe.

The Development of Criteria for Recreational Waters.

In: Discharge of Sewage from Sea Outfalls. A.L.H. Gameson, ed. Pergamon Press, London, 1975. pp. 63-73.

Key Words: salmonella, shigella, fecal streptococci, coliforms, drinking and recreational water.

Abstract:

Untoward effects on human health arising from the pollution of estuarine and coastal waters are obtained primarily through man's use of the marine environment as a source of recreation and food. Polluted shellfish as a potential route of disease transmission will be discussed later in this Symposium by Dr. Metcalf. The present report considers water-quality criteria for marine recreational waters, health-effects information needed as the basis for such criteria, past and present efforts to obtain this information, and the impact of these criteria on the treatment of domestic and industrial wastes discharged into estuarine and coastal waters.

Cabelli, V.J., A.P. Dufour, M.A. Levin, and P.W. Habermann.

The Impact of Pollution on Marine Bathing Beaches:
An Epidemiological Study (Personal Communication).

Key Words: epidemiology, drinking and recreational water.

Abstract:

Data on illness measured by symptomatology to some potential microbial indicator of water quality at the Coney Island and the Rockaways Beach during 1973 and 1974 are presented.

This original work is an excellent article on health effects criteria for marine recreational waters.

Cabelli, V.J., H. Kennedy, and M.A. Levin.

Pseudomonas aeruginosa - Fecal Coliform Relationships in Estuarine and Fresh Recreational Waters.

JWPCF. 48(2):367-376. February 1976.

Key Words: *Escherichia coli*, fecal streptococci, coliforms, surface water (fresh), drinking and recreational water.

Abstract:

Comparisons are made between the use of *Pseudomonas aeruginosa* instead of fecal coliform for the determination of fecal contamination in recreational water.

Caldwell, G.G., N.J. Lindsey, H. Wulff, D.D. Donnelly, and F.N. Bohl.

Epidemic of Adenovirus Type 7 Acute Conjunctivitis in Swimmers.

American Journal of Epidemiology. 99(3):230-234. 1974.

Key Words: adeno virus, epidemiology, drinking and recreational water.

Abstract:

An epidemic of acute conjunctivitis occurred in members of a Kansas community swimming team during January 1973. The etiological agent was adenovirus 7. Manifestations of illness occurred mainly in the eye; other systems were affected to a lesser degree.

The swimming team used a local junior high school swimming pool in which adequate chlorine levels were not maintained after the pool filter and chlorinator had failed.

California Morbidity.

Weekly Report from the Infectious Disease Section, California State Dept. of Health. April 9, 1976.

Key Words: epidemiology, copper.

Abstract:

Copper poisoning through food (a birthday cake) is discussed.

The dose of copper salts for hemorrhagic gastroenteritis is about 5 gm.

Last year, the Stanislaus City Health Dept. reported acute and violent illness in a family of four after drinking soda pop from a restaurant fountain. (The carbonated water was found to be the blame.)

Also, the Mendocino City Health Dept. reported that a soft drink vending machine caused copper poisoning.

California Morbidity.

Weekly Report from the Infectious Disease Section, California State Dept. of Public Health. June 11, 1976.

Key Words: epidemiology, drinking and recreational water.

Abstract:

Several cases of swimmer's itch (schistosome dermatitis) were reported in Alameda and Los Angeles Counties.

Eleven Girl Scouts contracted the disease after swimming in a lake in Shadow Cliffs Regional Park in Alameda County (in mid-May).

In May, 1976, similar reports were made from Castaic Lake After Bay, Los Angeles, County.

California Morbidity.

Weekly Report from the Infectious Disease Section, California State Dept. of Health. July 16, 1976.

Key Words: epidemiology, drinking and recreational water.

Abstract:

Waterborne outbreaks of a gastrointestinal illness were reported at Groves Hot Springs State Park, Alpine County, California in 1976.

Sixty people became ill during Memorial Day from water contamination.

California Morbidity.

Weekly Report from the Infectious Disease Section, California State Dept. of Public Health. September 3, 1976.

Key Words: epidemiology, hepatitis virus.

Abstract:

In the first week of August, four persons in a group of 59 travelers returned from overseas trips with hepatitis.

California Morbidity.

Weekly Report No. 39 from the Infectious Disease Section, California State Department of Health. October 8, 1976.

Key Word: epidemiology.

Abstract:

This report describes an outbreak of waterborne disease from a semi-private water system in Carmel Valley, Monterey County, California.

Canale, R.P.

Model of Coliform Bacteria in Grand Traverse Bay.

JWPCF. 45(11):2358-2371. November 1973.

Key Words: coliforms, surface water (fresh).

Abstract:

A predictive model for total coliform bacteria has been developed by using continuity equations with a simple fluid transport model and temperature-dependent first-order kinetics. The resulting linear equations can be solved easily and evaluated without the use of a computer. The model has been verified over a wide range of loadings during a period of several years with data obtained during numerous field surveys. The model has been applied to a number of problems of interest to local planners and other officials concerned with the control of water quality in Grand Traverse Bay.

Canale, R.P. , R.L. Patterson, J.J. Gannon, and W.F. Powers.

Water Quality Models for Total Coliforms.

JWPCF. 45(2):325-336. February 1973.

Key Words: coliforms, surface water (fresh).

Abstract:

First order kinetic formulations approximated the death curve of total coliform bacteria following an initial growth period in experiments where domestic wastewater was added to Lake Michigan water. Three separate studies using water collected during different seasons have demonstrated that the first-order rate coefficient is temperature dependent and relatively independent of illumination, prechlorination, and season of the year. The rate coefficient exhibits a linear variation with temperature. Equation 10 is the result of a linear fit of data obtained from these three studies and can be used to calculate the seasonal change of total coliform death rate caused by temperature changes in Lake Michigan waters.

The seasonal changes in total coliform density in the bay, as measured at the Traverse City municipal water intake, can be approximated using weighted sine and cosine series, auto-regression, and multiple-regression statistical models. Although it is possible to obtain a satisfactory fit of the data with each of these approaches, such models cannot be reliably used for long-range predictions. Further, the models are not based on an understanding of the mechanisms operative in the system and should be replaced in favor of models based on continuity equations for planning and control applications.

Historical data collected in Grand Traverse Bay demonstrate regular seasonal variations as well as long-range trends for total coliform density and turbidity. Additional data convey a consistent spatial pattern of total coliform at beaches in near-shore regions of the bay. These data and data from more recent surveys along with circulation patterns predicted from modeling studies suggest that a deterministic approach based on continuity equations may be possible. The verification and application of such models is the goal of current work.

Cancer and the Environment.

F.A.S. Public Interest Report. 29(5). May 1976.

Key Word: epidemiology.

Abstract:
Discussed are cancer incidence and cure rates and the Ames Test for carcinogens.

Carlson, C.A., P.G. Hunt, and T.B. Delaney, Jr.

Overland Flow Treatment of Wastewater.

U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss., August 1974. 119p. (Available from National Technical Information Service (NTIS) as AD/A-008-371).

Key Words: nitrates, phosphates, nickel, lead, cadmium, copper, manganese, mercury, zinc, ponding/land application, groundwater, surface water (fresh), crops.

Abstract:

Land application has been suggested as an effective, low-cost method for advanced treatment of wastewater from military reservation treatment plants. This study is being conducted to determine the mechanisms involved in wastewater treatment by overland flow so that operational feasibility, design, and performance criteria can be more accurately evaluated. A model 5 ft wide and 20 ft long was prepared with grass sod and a low-permeable Susquehanna clay to a 6-in. depth at a 2 percent slope. Secondary effluent from a model treatment plant was supplemented with 13.4 mg/l of nitrogen as ammonium nitrate and 0.2 mg/l each of cadmium, copper, lead, manganese, nickel, and zinc to simulate average wastewater. The study was conducted for 12 weeks with effluent applied by flooding from the upper end of the slope at 0.5 in./day (6-hr periods) for 4 days per week. The wastewater was generally distributed into 20, 30, and 50 percent for subflow, evapotranspiration, and runoff, respectively. Analyses showed that 100, 95, 91, and 75 percent of the ammonium, nitrate, and organic nitrogen and phosphorus, respectively, were retained in the model. The balance of the nitrogen and phosphorus remained in the runoff, with essentially none in the subflow. The grass harvest removed 31 percent of the nitrogen and 6 percent of the phosphorus. The model retained from 98 to 100 percent of the cadmium, copper, manganese, and nickel; 91 percent of the lead; and 72 percent of the zinc. The balance was lost in runoff, except for 2 percent manganese and 6 percent zinc that were lost in the subflow. The grass removed 4 percent of the applied copper, lead, and nickel; 9 percent of the zinc; 13 percent of the manganese; and none of the cadmium.

Carlson, R.M., R.E. Carlson, H.L. Kopperman, and R. Caple.

Facile Incorporation of Chlorine into Aromatic Systems
During Aqueous Chlorination Process.

Environmental Science and Technology. 9:674-675.
July 1975.

Key Words: synthetic/organics, chlorination.

Abstract:
It has been observed that chlorine is readily incorporated into aromatic compounds under those conditions utilized for water renovation. The extent of chlorine incorporation varies with pH and contact time.

Carlucci, A.F. and D. Pramer.

Factors Affecting the Survival of Bacteria in Sea Water.

Applied Microbiology. 7(6):388-392. November 1959.

Key Words: bacteria, surface water (marine).

Abstract:

Great numbers of bacteria enter the sea by way of surface drainage and sewage outfalls but, as one proceeds outward from land, an extremely rapid decrease in the numbers of bacteria in the water is observed. Numerous explanations for the decrease in numbers have been suggested. Dilution, adsorption, and sedimentation are factors of importance but they do not account fully for the rapid disappearance of bacteria that enter the sea. The significance of biological factors has been emphasized by various investigators who observed that the survival of bacteria is greater in heat sterilized sea water than in untreated sea water. Although it has been postulated that predators, bacteriophages, and heat labile toxic substances of biological origin (antibiotics) contribute to the rapid death of bacteria in natural water, the evidence is primarily indirect and, therefore, not conclusive. Hydrostatic pressure, solar radiation, temperature, salinity, pH, oxidation-reduction potential, and nutrient availability are physicochemical factors known to influence the activities of microorganisms, but their significance in maintaining the bacterial population of the sea at a reduced level ramains to be evaluated. Likewise, our present knowledge of the interrelationships of microorganisms in marine environments must be extended before the bactericidal action of sea water can be explained.

Carlucci, A.F. and D. Pramer.

Factors Influencing the Plate Method for Determining Abundance of Bacteria in Sea Water.

Proceedings of the Society for Experimental Biology and Medicine. 96:392-394. 1957.

Key Words: bacteria, surface water (marine).

Abstract:
The nutritional requirements of marine bacteria are so varied that no one nutrient medium can suffice for the growth of all. The influence of composition of the nutrient medium and plating procedure on the plate method for determining the number of bacteria in sea water was investigated. Seven media were tested. Maximum and reproducible plate counts were obtained with medium containing 0.5% peptone, 0.01% yeast extract, 0.01% $FePO_4$ and 1.5% agar in 80% sea water. The number of colonies that developed on pour plates was 30-40% greater than the number that developed on surface inoculated plates.

Carlucci, A.F., P.V. Scarpino, and D. Pramer.

Evaluation of Factors Affecting Survival of Escherichia coli in Sea Water; V: Studies with Heat- and Filter-Sterilized Sea Water.

Applied Microbiology. 9(5):400-404. September 1961.

Key Words: epidemiology, Escherichia coli, surface water (marine).

Abstract:

The bactericidal action of sea water was measured as the difference in survival of cells of Escherichia coli in untreated and autoclaved portions of water samples. The beneficial effect of sterilization by heat on the survival of E. coli in sea water varied with season and was most marked during summer months, however, the magnitude of the effect differed greatly from sample to sample. The more obvious and commonly suggested explanations for the bactericidal action of sea water were tested experimentally. The pH and salinity of sea water were changed by autoclaving, but the direction of the former was detrimental rather than beneficial and the significance of the latter was not clarified. The survival of cells of E. coli in filtered portions of some water samples was greater than that in untreated portions and equal to that in autoclaved portions, indicating that predators and competitors removed by filtration had contributed significantly to the rapid death of the bacterium in the untreated water. However, in the majority of samples tested, survival of E. coli in autoclaved water was considerably greater than survival in filtered water.

The possibility that the beneficial effect of autoclaving over and above that of filtration resulted from inactivation or destruction by heat of bacteriophages and thermolabile toxic substances such as antibiotics was considered. Moreover, the suggestion was tested that the increased survival of E. coli in autoclaved sea water was due to the ability of heat to disrupt and degrade microbial cells and thermolabile compounds and, thereby, to cause an increase in concentration of available nutrients in sea water.

It was concluded that the bactericidal action of sea water is not explicable in terms of the destruction or inactivation by heat of bacteriophages or antibiotics. Although added organic matter influenced the survival of *E. coli*, the test organism was not an effective competitor in sea water and the nutrient levels required to offset the bactericidal action were excessive.

Carnes, B.A. and J.M. Eller.

Characterization of Wastewater Solids.

JWPCF. 44(8):1498-1517. August 1972.

Key Words: suspended solids, effluent characteristics.

Abstract:
This article provides a general discussion on wastewater solids. There are no health effects data given.

Carnes, B.A., J.M. Eller and J.C. Martin.

Integrated Re-Use-Recycle Treatment Processes Applicable to Refinery and Petrochemical Wastewaters.

American Society of Mechanical Engineers, New York. 1971. 11p.

Key Words: BOD, suspended solids, total dissolved solids, ammonia, phosphates, activated sludge, adsorption/ion exchange.

Abstract:

Estimated effluent quality for the activated sludge, carbon, and combined treatment of refinery wastewaters are discussed.

Carney, J.F., C.E. Carty, and R.R. Colwell

Seasonal Occurrence and Distribution of Microbial Indicators and Pathogens in the Rhode River of Chesapeake Bay.

Applied Microbiology. 30(5):771-780. November 1975.

Key Words: fecal streptococci, coliforms, bacteria, surface water (fresh), surface water (marine).

Abstract:

The seasonal incidence and occurrence of indicator organisms and pathogens were studied at four sites in the Rhode River, a subestuary of Chesapeake Bay. The highest frequency of occurrence of total and fecal coliforms and fecal streptococci was in Muddy Creek, a marsh area receiving pasture land runoff. Second highest frequency of occurrence of these bacteria was in Cadle Creek, a populated area. Lowest measurements of these parameters were obtained at stations in the central portion of the Rhode River. No *Salmonella* spp. were detected by the methods employed in this study. However, it is concluded that if these organisms are present, the concentrations are ≤ 1 organism per liter. The presence of *Clostridium botulinum* was detected in 12% of the samples tested.

Carpenter, R.L., H.K. Malone, A.F. Roy, A.L. Mitchum, H.E. Beauchamp, and M.S. Coleman.

The Evaluation of Microbial Pathogens in Sewage and Sewage-Grown Fish.

In: Wastewater Use in the Production of Food and Fiber-Proceedings. EPA-660/2-74-041, U.S. Environmental Protection Agency, Washington, D.C., Office of Research and Development, June 1974. pp. 46-55.

Key Words: viruses, bacteria, aerated lagoons, fish, coliforms.

Abstract:

It can be said that this study has confirmed the previous observations of others that indicator coliform organisms are efficiently removed in a lagoon-method wastewater treatment system. This study has shown that human pathogens are rare in those wastewaters tested and in fish grown in those wastewaters beyond the raw or first two conventionally-operated cells.

Carr, R.L., C.F. Finsterwalder, and M.J. Schibi.

Chemical Residues in Lake Erie Fish - 1970-71.

Pesticides Monitoring Journal. 6(1):23-26. June 1972.

Key Words: pesticides, DDT, DDE, dieldrin, chlorinated hydrocarbons, mercury, fish.

Abstract:

Yellow perch, coho salmon, carp, channel catfish, freshwater drum, and white bass from the Ohio shore of Lake Erie were analyzed during 1970-71 for residues of chlorinated pesticides (DDE, TDE, DDT, and dieldrin), polychlorinated biphenyls (PCB's), and mercury. All but 1 of the 80 samples analyzed contained DDT and/or its metabolites; PCB's were found in all samples. Fifty-three of the 80 samples were analyzed for mercury, and all were found positive.

Average levels of residues for the species sampled ranged from 0.06 to 0.42 ppm for DDE; 0.07 to 0.52 ppm, TDE; 0.03 to 0.25 ppm, DDT; 0.18 to 0.90 ppm, total DDT; 0.01 to 0.07 ppm, dieldrin; 0.08 to 4.4 ppm, PCB's; and 0.12 to 0.64 ppm, mercury. The highest average residue levels of total DDT were in coho salmon and channel catfish. Average levels of PCB's were significantly higher in channel catfish, and levels of mercury were significantly higher in white bass.

Carroll, T.E., D.L. Maase, J.M. Gemco, and C.N. Ifeadi.

Review of Landspreading of Liquid Municipal Sewage Sludge.

EPA-670/2-75-059, Battelle-Columbus Laboratories, Columbus, Ohio, June 1975. 95p. (Available from National Technical Information Service (NTIS), as PB-245 271).

Key Words: fecal streptococci, coliforms, *Escherichia coli*, mycobacterium, salmonella, shigella, leptospirosis, *Vibrio cholerae*, parasitic worms, ponding/land application, agriculture, crops, food processing, livestock.

Abstract:

This article gives a summary of the significant literature on landspreading of liquid sludge relative to: occurrence and movement of pathogens in the soil, survival of pathogens in the soil, and health hazards posed to humans and animals.

Carry, D.W., R.P. Miele, and J.F. Stahl.

Sludge Dewatering.

In: Municipal Sludge Management; Proceedings of the National Conference on Municipal Sludge Management, 1974. pp. 67-76.

Key Words: BOD, suspended solids, centrifugal thickeners, vacuum filters, pressure filtration.

Abstract:

Commencing in April 1970, an extensive sludge dewatering investigation was undertaken at the Los Angeles County Sanitation Districts' 380 mgd Joint Water Pollution Control Plant. Discharge requirements set by the Los Angeles Regional Water Quality Control Board necessitated that a minimum of 95 percent of the suspended solids in the digested sludge be removed. Various combinations of sludge conditioning (polymer, chemical, thermal) and sludge dewatering (centrifugation, pressure filtration, vacuum filtration) were examined, the results of which indicated that five conditioning-dewatering systems were capable of meeting the required effluent quality. An economic evaluation was made of each system, from which a two stage centrifugation system was found to be the alternative of lowest cost. The system consisted of the existing hoizontal scroll centrifuges and imperforate bowl basket centrifuges with polymer conditioning for the second stage basket machines. The composite sludge cake from the system will be hauled to a sanitary landfill for ultimate disposal.

Carter, C.D., R.D. Kimbrough, J.A. Liddle, R.E. Cline, M.J. Zeck, Jr., and W.F. Barthel.

Tetrachlorodibenzodioxin: An Accidental Poisoning Episode in Horse Arenas.

Science. 188(4189):738-740. May 16, 1975.

Key Words: epidemiology.

Abstract:

This report describes the first recognized incident in which significant poisoning resulted from the improper disposal of waste residues containing tetrachlorodibenzodioxin (TCDD). A salvage oil company sprayed an arena on a horse breeding farm in eastern Missouri with waste oil sludge for the purpose of controlling dust. Three days later sparrows and other birds which normally populated the barn rafters were found dead on the arena floor. Hundreds of birds, several cats and dogs, and numerous rodents died over the next several weeks after exposure to the arena. Of the 125 horses on the farm, 85 were exercised for varying periods within the arena and of these, 62 became ill and 48 died. The first horse death occurred on 20 June, and although soil was removed from the arena in October 1971 and April 1972, horses continued to die as late as January 1974. All of those which died had been exposed to the arena in the summer of 1971. Horses showed chronic emaciating weight loss, loss of hair, skin lesions, dependent edema, intestinal colic, dark urine, gross hematuria, conjunctivitis, joint stiffness, and laminitis. In addition to the laminae, the soles and frogs of the horses' feet were particularly inflamed. Similar results occurred after the same company sprayed two additional arenas and a farm dirt road. Human illness, though less severe, included one case of hemorrhagic cystitis in a 6 yr old girl who played in the arena. Analysis of the soil in the arena revealed 2,4,5-trichlorophenol (TCP), TCDD, and related chemicals. Confirmation of the presence of TCDD was obtained by tests in rabbits and by using an LKB 9000 gas chromatograph-mass spectrometer. The horse arena soil contained 31.8 to 33μg of TCDD/g. As commercial-grade products do not contain such high concentrations of TCDD, an industrial waste by-product of chlorinated aromatic compounds was suspect. The sludge used to spray all 3 arenas came

from a common storage tank at the salvage oil company. Salvage oils in this tank had been collected from a variety of sources in eastern Missouri. A hexachlorophene producer in southwestern Missouri contracted disposal of an accumulated distillate residue to a chemical distributor. This distributor subcontracted this disposal job to the salvage oil company which sprayed the three affected arenas. The residue of the hexachlorophene producer had been stored for a time in the same tank from which the sludge had been taken to spray the arenas. This investigation demonstrates that the improper disposal of toxic chemical wastes may have disastrous consequences.

Carter, L.J.

Cancer and the Environment (I): A Creaky System Grinds On.

Science. 186:239-242. October 1974.

Key Words: pesticides, aldrin, dieldrin, chlorinated hydrocarbons, epidemiology.

Abstract:
This article provides a general discussion on the role of pesticides as carcinogens and the bureaucratic red-tape in the cancellation of the registration of known carcinogens.

Case, O.P.

Metallic Recovery from Waste Waters Utilizing Cementation.

EPA-670/2-74-008, Anaconda American Brass Company, Westbury, Conn., Engineered Environments Division. January 1974. 44p. (Available from National Technical Information Service (NTIS) as PB-233 143).

Key Words: leptospirosis, Francisella tularensis, chemical treatment.

Abstract:

The report presents the results of a series of bench-scale experiments using the so-called 'cementation' reaction (i.e., electrochemical reduction by contact with a metal of higher oxidation potential) for the precipitation of copper and the reduction of hexavalent chromium in industrial waste streams such as brass mill and metal finishing discharges. Reluctants studied included soft iron shot, particulate iron, and silicon alloys in granular form. The bulk of the work was done using the iron shot as a reductant. Studies were carried out by both a batch process and a continuous process (black-mix reactor). Results were evaluated in terms of percent reduction, dissolution of excess iron and change in pH vs time.

Cassel, A.F. and R.T. Mohr.

Sludge Handling and Disposal at Blue Plains.

In: Municipal Sludge Management; Proceedings of the National Conference on Municipal Sludge Management, 1974. pp. 171-176.

Key Words: BOD, cadmium, copper, lead, nickel, zinc, anaerobic digestion, influent characteristics, effluent characteristics.

Abstract:

Blue Plains Wastewater Treatment Plant is a regional facility serving most of the Metropolitan Washington Area. The plant is now undergoing expansion and the addition of advanced wastewater treatment. In the past, anaerobically digested sludge was all disposed on the land. At the present time both raw and digested sludge is undergoing disposal by a variety of techniques including land spreading, burial, composting, and thermal dehydration. For future disposal of sludge, a combination of methods, including land spreading, composting, thermal dehydration, and incineration are now under evaluation. The District's priorities are to work within all regulatory guidelines and process the sludge into a reusable commodity.

Catanzaro, E.J.

Some Relationships between Exchangeable Copper and Lead and Particulate Matter in a Sample of Hudson River Water.

Environmental Science and Technology. 10(4):386-388. April 1976.

Key Words: copper, lead, surface water (fresh).

Abstract:

In any natural water system, copper and lead occur in solution on the surface of particles and inside particles. Most analyses of trace metals in natural waters are concerned with quantities in solution (i.e., $<0.45\mu$), within solids (which are dissolved in the analysis), or both. Some analyses are concerned with "leachable" quantities of these elements, usually at various acid strengths.

In the present study an isotope dilution technique was used which measured the "exchangeable" copper and lead in slightly acidified aliquots of a sample of Hudson River water from which various sizes of particulate matter had been removed.

In summary, it is rather difficult to propose concrete conclusions on the basis of the small amount of data presented here, but the results do support the tentative conclusions reached in the discussion and certainly suggest that differential analysis of the components of river water will prove fruitful for the study of trace metal cycles.

Cearley, J.E. and R.L. Coleman.

Cadmium Toxicity and Bioconcentration in Largemouth Bass and Bluegill.

Bulletin of Environmental Contamination and Toxicology. 11:146-151. February 1974.

Key Words: cadmium, fish, surface water (fresh).

Abstract:

The exposure of juvenile largemouth and bluegill to cadmium (0.0005 to 0.85 mg/liter) resulted in accumulation of this metal in concentrations greater than those of the water. The quantity of metal accumulated increased as the exposure concentration increased. An equilibrium developed between the concentrations of the metal in the water and in the tissues after approximately 2 months. Metal accumulations on the bass tissues were higher in the internal organs, followed by the gills and the remainder of the body.

The bass were more sensitive to cadmium than the bluegill. Abnormal behavior patterns observed in both species suggested that the nervous system was the site of the damage.

Chadwick, G.G. and R.W. Brocksen.

Accumulation of Dieldrin by Fish and Selected Fish-Food Organisms.

Journal of Wildlife Management. 33:693-700. July 1969.

Key Words: pesticides, dieldrin, fish.

Abstract:

The rate of uptake of 1,2,3,4,10,10-hexachloro-6, 7-epoxy-1, 4,4a,5,6,7,8, 8a-octahydro-1, 4-endo, exo-5, 8-dimethanonaphthalene (a component of dieldrin abbreviated HEOD) from contaminated water or food by the reticulate sculpin (Cottus perplexus) and fish-food organisms, tubificid worms (Tubifex sp.) and midge larvae (Chironomidae) was determined. Fish were held in aquaria with continuously renewed water that had concentrations of HEOD ranging from 0.017 to 8.6 parts per billion (ppb). Accumulation of HEOD by the fish was dependent on its concentration in the water, and the accumulation was nearly constant at each exposure level during the 32-day test period. The saturation level of HEOD in the fish apparently was never reached.

Feeding experiments, using contaminated tubificid worms as the food source, showed that the retention of HEOD by fish was inversely related to the amount of HEOD they consumed. Fish retained nearly all of the HEOD they consumed when given small amounts in their food, but they retained a much lower proportion of the available HEOD when given large amounts in food. Feeding duration (up to 30 days) of the fish had little effect upon their retention of HEOD.

It is evident that fish can accumulate HEOD both from the surrounding water and from their food, but accumulation of HEOD from the water does not appear to be additive with the HEOD accumulated from the food. Fish held in water having a concentration of 0.5 ppb HEOD, and fed worms containing known amounts of HEOD, did not accumulate more HEOD than fish held in the same concentration of HEOD and fed uncontaminated worms.

Chahal, K.S.

Microbial Activities during Sewage Treatment in Lagoons. I. Changes in Aerobic and Anaerobic Bacteria, Actinomycetes, and Fungi. II. Changes in Different Types of Fungi. III. Changes in BOD and Dehydrogenase Activity.

Tuskegee Institute, Ala., Carver Research Foundation, 1974. 43p. (Available from National Technical Information Service (NTIS) as PB-237 501).

Key Words: BOD, activated sludge, ponding/land application.

Abstract:

Two domestic sewage lagoons were used to study biological oxygen demand (BOD) and dehydrogenase activity changes during one-year period. Both BOD and dehydrogenase activity were higher during summer months than winter. BOD in the effluent followed the same pattern as BOD in the influent. Dehydrogenase activity and BOD followed the same trend during the one-year period of this study. It is suggested that due to simplicity, fastness and accuracy of the method, dehydrogenase activity may be a better method to determine the oxidation rate in sewage lagoons and wastewaters.

Chambers, D.W.

Chlorination for Control of Bacteria and Viruses in Treatment Plant Effluents.

JWPCF. 43(2):228-241. February 1971.

Key Words: bacteria, viruses, chlorination.

Abstract:

The main objective is to provide a basic understanding of some of the important factors that affect the efficiency of chlorination in controlling bacteria and viruses in wastewater effluents. Research data and examples from practical operation, along with reference material in the literature, have been combined to provide a starting base. This information should be evaluated for its relevance to specific plant situations and, where appropriate and pertinent, can then be used to provide guidelines for practical disinfection applications in the plant.

Chaney, R.L.

Crop and Food Chain Effects of Toxic Elements in Sludges and Effluents.

In: Recycling Municipal Sludges and Effluents on Land; Proceedings of the Joint Conference, July 9-13, 1973. pp. 129-141.

Key Words: boron, cadmium, chromium, cobalt, copper, lead, mercury, nickel, zinc.

Abstract:

Sewage sludge and effluent are applied to soil with the intent that toxic elements be retained by the soil. These elements will accumulate and persist, and are the long term environmental hazard in land application. Elements in sludge and effluent that are potential hazards to plants or food chain are: B, Cd, Co, Cr, Cu, Hg, Ni, Pb, and Zn. The direct toxicities to plants from Zn, Cu and Ni are discussed in detail. Hazard to the food chain from Cd, Cu, Zn, Pb, and Hg in crops grown on sludge- and effluent-treated soils is discussed, with emphasis on the controllable hazard from Cd. Crop differences in injury from, and accumulation of Cd, Cu, Zn, and Ni are discussed in relation to the high phosphate and organic matter contents of sludge and effluent. Interim recommendations are made for permissible levels of toxic metals added to agricultural soils. Research needs to protect plants and the food chain are presented.

Chaney, R.L., S.B. Hornick, and P.W. Simon.

Heavy Metal Relationships during Land Utilization of Sewage Sludge in the Northeast.

In: Land as a Waste Management Alternative; Proceedings of the 1976 Cornell Waste Management Conference. R.C. Loehr, ed.
Ann Arbor Science Publishers, Ann Arbor, Mich., 1977.
pp. 283-314.

Key Words: cadmium, chromium, copper, iron, lead, manganese, nickel, zinc, agriculture, crops, combined municipal/industrial system.

Abstract:

A program was started in the Laboratory to: (1) locate long-term sludge use sites with a wide range of soil Cd contents, (2) grow and analyze a number of crops representing a range of Cd accumulation characteristics on these sites and matched control fields, and (3) characterize existing sludge use practice regarding heavy metals in sludges, soils, and crops. This paper is a preliminary report of the results of these studies, showing sludge composition, metal accumulation in treated soils, and crop uptake of heavy metals from treated and control soils. These studies have shown that use of high Cd sludges leads to long-term increases in crop Cd, but that proper soil pH management and crop selection can minimize the impact of sludge use on farmland on Cd movement into the food chain.

Chang, P.W.

Effect of Ozonation on Human Enteric Viruses in Water from Rhode Island Rivers.

Rhode Island University, Kingston, Dept. of Animal Pathology, July 1974. 21p.. (Available from National Technical Information Service (NTIS) as PB-236 421).

Key Words: adenovirus, coxsackie virus, ECHO virus, polio virus, ozonation.

Abstract:

Partially purified poliovirus type 1, 2 and 3, Coxsackie virus type B3 and B5, echovirus type 12 and 29, and adenovirus type 7a were studied for their sensitivity to ozone demand-free distilled water or Saugatucket River water. An ozone sparging rate of one gram per hour was used. Viruses were sampled at various intervals during ozonation and assayed. The different viruses varied in their sensitivity to ozone and ranged from one to 14 minutes for their inactivation. The time required to inactiveate viruses in river water was in most cases twice as long as that required for the ozone demand-free distilled water.

Chang, S.L.

Modern Concept of Disinfection.

Journal of the Sanitary Engineering Division, ASCE.
97(SA5):689-707. October 1971.

Key Words: viruses, bacteria, ozonation.

Abstract:

In a critical review of the literature on disinfection as a chemical process the following conclusions are reached:

1. The knowledge of disinfection is founded on physico-chemistry of the disinfectant, the cytochemical nature and physical state of the microorganisms, the reaction of the two as a rate process, and the quantitative effects of factors, such as pH, temperature, etc.

2. Disinfectants may be grouped into: oxidizing agents, cations of heavy metals, quaternary ammonium and pyridinium compounds, gaseous agents, and physical agents. The mode of action is different with each group of agents.

3. Microorganisms are grouped into amoebic cysts, bacteria, and viruses (with spores omitted); their difference in cyto-structure accounts for the difference in resistance to disinfectants.

4. The presence of organisms in aggregates is believed to be the main, if not only, cause for aberrations in survival curves; such data should be analyzed as complex phenomenon in order to obtain the death rate constant, k, for the destruction of organisms as singles. Methods for such analysis are presented.

5. Various constants and other quantitative parameters obtained from analyses of existing data on disinfection are tabulated; the table reveals much information has yet to be obtained.

Chapman, B.

Sponsors of Science Inc. on Safety of 2,4,5-T and Dioxin.

Clinical Toxicology. 7(4):413-421. 1974.

Key Word: epidemiology.

Abstract:

The safety and toxicity of 2,4,5-T and DDT are discussed in a letter written to Senator Gaylord Nelson. Both compounds are rated in comparative toxicity tables as among the least hazardous pesticides for human use. The actual amount of the technical (1,000,000 ppm) compound eaten determines the toxicity. Based on the acute oral toxicity expressed in mg/kg, a 125 lb woman would have to eat her body weight equivalent of material containing 380 ppm of 2,4,5-T to receive a lethal dose. Both 2,4,5-T and DDT in technical form are relatively non-toxic on skin contact (3800 mg/kg for 2,4,5-T and 2500 mg/kg for DDT). The toxicity of the dioxins contained in 2,4,5-T has little, if any, influence on the toxicity of the 2,4,5-T. There have been no human deaths and remarkably few human illnesses because of the agricultural or public health uses of either of these chemicals. There are no significant differences between the health of workers in 2,4,5-T or DDT manufacturing plants and the norm for the general population. Many researchers believe it would be completely erroneous to classify the 2,4,5-T currently manufactured as a teratogen. A no-effect level of 50 mg/kg/day of 2,4,5-T containing less than 1 ppm dioxins is proposed as providing ample protection for human embryos.

Chapman, H.D., ed.

Diagnostic Criteria for Plants and Soils.

Quality Printing Company, Abilene, Texas, 1965. 794p.

Abstract:

All the pertinent articles herein are listed individually with their own key words, abstracts, etc.

Chapman, H.D.

Zinc.

In: Diagnostic Criteria for Plants and Soils. Quality Printing Company, Abilene, Texas, 1973. pp. 484-499.

Key Words: zinc, ponding/land application, land reclamation, groundwater, crops.

Abstract:

The author discusses plant and soil criteria useful in diagnosing zinc status, including visual symptoms of and indicator plants for zinc deficiency or excess, tissue and analysis values, kinds of soil in which zinc deficiency or excess occur, soil management and other practices that aggravate or reduce zinc deficiency or produce toxicity, soil analysis values of significance and control or methods of correcting zinc deficiency.

Chapman, S.W. Jr., R.M. Sweazy, and D.M. Wells.

Nitrogen Mass Balance Determination for Simulated Waste-Water Land Spreading Operations.

Texas Tech University, Lubbock, Water Resources Center, December 1974. 44p. (Available from National Technical Information Service (NTIS) as PB-239 406).

Key Words: ammonia, nitrates, nitrites, ponding/land application, groundwater.

Abstract:

Results of this research project have shown that irrigation with a sewage effluent on the High Plains of Texas is a potential source of groundwater pollution. Ammonia in a sewage effluent applied at normal rates will be completely nitrified as it percolates through the Amarillo soil. The nitrification process will probably occur within the top three feet of the soil profile, making the nitrates available for plant uptake. The mass balance indicated that appreciable amounts of nitrogen will not be fixed in soils on the High Plains since more nitrogen was leached from the bins than was applied. If effluents are applied at the project's 3-inch per week rate, an appreciable amount of this water will percolate to the aquifer even during periods of maximum evapotranspiration.

Selective crop production is probably the most effective method of protecting High Plains groundwater from sewage irrigation. Planting and harvesting of crops that have a high nitrogen uptake, such as Bermuda grass and corn would remove large amounts of nitrates. Since most irrigation projects must dispose of wastewater all year, winter crops such as oats, wheat, and barley should be planted. Loading rates should be such that nitrogen uptake by the crop approximates the nitrogen applied in the sewage effluent.

Chaudhuri, M. and R.S. Engelbrecht.

Removal of Viruses from Water by Chemical Coagulation and Flocculation.

JAWWA. 62(9):563-567. September 1970.

Key Words: viruses, chemical treatment.

Abstract:

Based on the laboratory investigation reported, using bacterial virus, the following conclusions may be drawn:

1. Chemical coagulation and flocculation is an effective process in removing viruses from water. Removals in the range of 98.0 to 99.9 percent can be expected.

2. The presence of bivalent cations like calcium and magnesium up to a concentration of 50 mg/l each does not interfere with the efficiency of the process.

3. The efficiency of virus removal is reduced when the raw water contains organic matter.

4. Intelligent use of commercially available cationic polyelectrolytes with or without hydrolyzed metal ions most markedly increase the efficiency of the coagulation and flocculation process removing virus.

Chaudhuri, M. and R.S. Engelbrecht.

Virus Removal in Wastewater Renovation by Chemical Coagulation and Flocculation.

Advances in Water Pollution Research. 1970(1):II-20/1-22.

Key Words: viruses, chemical treatment.

Abstract:

Based on the findings of this investigation, the following conclusions may be drawn:

1. Removal of viruses by chemical coagulation and flocculation with aluminum sulfate comprises of a primary instantaneous interaction between virus coat protein and aluminum which results possibly in the formation of coordination complexes between aluminum and the carboxyl groups of the virus coat protein. This is followed by their incorporation into the precipitating hydrated aluminum oxide species and subsequent flocculation and sedimentation. Additional work is in progress in this area and the results will be reported in a later publication.

2. The process of chemical coagulation and flocculation cannot be expected to operate with high virus removal efficiency in wastewater renovation as compared to water treatment because of the presence of organic matter in wastewater effluent.

3. Virus particles removed in the settled floc are not inactivated but remain active. Therefore, proper care should be taken in the disposal of sludge from coagulation-flocculation operation in wastewater renovation.

Chemistry of Nitrogen and Phosphorus in Water.

JAWWA. 62(2):127-140. February 1970.

Key Words: ammonia, nitrates, nitrites, phosphates, surface water (fresh), surface water (marine).

Abstract:

This paper is a general write-up of the role of nitrogen and phosphorus in water.

Chen, C., L.S. Directo, H.B. Ghan, M.W. Selna, and D.L. Weisman.

Virus Study . . . Pomona.

County Sanitation Districts of Los Angeles County, Los Angeles, California.

Key Words: viruses, wastewater treatment.

Abstract:

This paper is a study proposal to rank the alternative treatment schemes in terms of virus removal effectiveness.

Chen, C.L.

Virus Removal (Personal Communication). September 1975.

Key Words: polio virus, filtration, chemical treatment, adsorption/ion exchange, chlorination, ozonation.

Abstract:
This article discusses a treatment scheme used to study virus removal.

Chen, C.L. and R.P. Miele.

Wastewater Demineralization by Two-Stage Fixed-Bed Ion Exchange Process.

EPA-600/2-77-146, Municipal Environmental Research Center, Cincinnati, Ohio, September 1977. 83p. (Available from National Technical Information Service (NTIS) as PB-272 591).

Key Words: total dissolved solids, adsorption/ion exchange.

Abstract:

The ion exchange pilot plant has successfully demineralized wastewater at Pomona, California for over 4 years. Various studies have investigated particular aspects of the process to the point where the most efficient mode of operation has been concluded. Cost estimates for the ion exchange process show that a blended water with one-third of the influent TDS removed can be produced at a cost competitive with alternative sources of water for Southern California, and even further economics may be realized during more extensive research on ion exchange. It is now possible to speak of a demineralization process for wastewater which has proven economic and technical applicability.

Chen, C.W.

Effects of San Diego's Wastewater Discharge on the Ocean Environment.

JWPCF. 42(8):1458-1467. August 1970.

Key Words: chlorides, nitrates, total organic carbon, surface water (marine).

Abstract:

A comprehensive interpretation of massive monitoring data requires a close examination of the information from various angles with different analytical techniques. These would normally take a formidable amount of computations. In this study, the necessary analytical techniques were adapted for computer operation to facilitate a rapid and systematic distillation of information from such a body of data collected near the city of San Diego's Wastewater Outfall. The objective is to obtain an overall picture of what is taking place in the ocean environment after the discharge of wastewater.

The methods of evaluation include variance and time series analyses of physical, chemical, and biological parameters. The population trend and composition of biota are also analyzed to detect the ecological shift. Results indicate the following general conclusions concerning the effects of San Diego's waste discharge on the nearby ocean environment:

1. The outfall performed effectively in diffusing wastes to the environment; only minimal changes in quality parameters in the water column could be detected by statistical analyses - most were correlatable with ambient climatic conditions.

2. Quality changes that were detected indicated that the environment was gradually reaching an equilibrium state, somewhat stimulated but with no definitely discernable adverse effects.

3. The marine eco-system was more or less stable in composition both in planktonic and benthic forms, but the benthic populations were stimulated in total growth by the waste discharge and deposit of organic matter.

Chen, C.W. and G.T. Orlob.

The Accumulation and Significance of Sludge Near San Diego Outfall.

JWPCF. 44(7):1362-1371. July 1972.

Key Words: BOD, surface water (marine).

Abstract:

Sludge accumulation around the San Diego marine outfall was shown to be a function of (a) initial mixing, (b) lateral dispersion, (c) sedimentation rate, and (d) decay of organic particulates. Theoretical computations predicted the development of an elliptical sludge blanket. This was confirmed by a monitoring program conducted by the city of San Diego. Analysis of 6 yr of monitoring sediment composition revealed that (a) contours of sediment BOD before discharge were oriented parallel to the shoreline, (b) oval-shaped BOD contours were formed by sludge deposition following outfall installation, and (c) changes in contour pattern and intensities of organic accumulation were related to treatment plant performance, and in particular to the discharge of digested sludge through the outfall.

Analysis of benthic animal data disclosed that the compositions of the communities stayed essentially the same, predominant groups remained predominant, and little change in diversity occurred. Biostimulation of benthic animals was maximal at about 1.5 miles (2.42 km) from the diffuser. It was concluded that sludge buildup causing an increase of more than 3 mg/g of BOD in the sediments would result in some depression in biological growth in the benthos.

Chen, K. and T. Hendricks.

Trace Metals on Suspended Particulates.

Southern California Coastal Water Research Project.
Annual Report. El Segundo, Ca., June 30, 1974. pp. 147-152.

Key Words: cadmium, chromium, copper, lead, manganese, mercury, nickel, zinc, activated sludge, surface water (marine).

Abstract:

While secondary treatment removed 93% of suspended solids, a corresponding reduction in heavy metals did not exist. After drawing correlations between particle size and trace metal concentrations, the authors concluded that trace metals are more or less uniformly distributed throughout the particulate rather than being absorbed on the surface.

Chen, K.Y. and R.A. Lockwood.

Evaluation Strategies of Metal Pollution in Oceans.

Journal of the Environmental Engineering Division, ASCE. 102(EE2):347-359. April 1976.

Key Words: cadmium, chromium, copper, iron, manganese, mercury, lead, nickel, gravity separators, activated sludge, anaerobic digestion, zinc, surface water (marine).

Abstract:
A common practice of dilution and dispension of sewage effluents in the ocean has an unknown effect on particulates. We want to determine the final sink of contaminants and level of exposure and possible uptake through the food chain. The partioning of trace metals between settleable and soluble or colloidal phase following release into ocean waters is of prime importance. Seven parameters are discussed which are important in evaluating ecological effects:

1. Association of heavy metals with settleable solids;

2. Settling characteristics of solids in waste streams;

3. Particle size correlation to metal content;

4. Chemical elutriation;

5. Release of trace metals upon mixing, dispersion, and settling;

6. Bioassays; and

7. Chemical analyses to determine toxicities and food-chain enrichment potentials of particular waste streams or elutriates or specificial chemical solids.

Chen, K.Y., C.S. Young, T.K. Jan, and N. Rohatgi.

Trace Metals in Wastewater Effluents.

JWPCF. 46(12):2663-2675. December 1974.

Key Words: cadmium, chromium, copper, manganese, iron, nickel, zinc, effluent characteristics, centrifugal thickeners.

Abstract:

The concentrations of trace metals in the particulate fraction of wastewater effluents will reflect the possible enrichment of the discharge areas. Concentrations of trace metals were found to be at a distinctly higher level above natural coastal sediment concentrations in the vicinity of the major wastewater outfalls in the Southern California area; a possible mitigation is the reduction of solid content in the effluent discharge.

Cheng, M.H., J.W. Patterson, and R.A. Minear.

Heavy Metals Uptake by Activated Sludge.

JWPCF. 47(2):362-376. February 1975.

Key Words: cadmium, copper, lead, nickel, activated sludge.

Abstract:

Under aerobic conditions, metal uptake by the biomass is characterized by a very rapid phase of 3 to 10 min followed by a long-term, slow-phase uptake. At lower metal concentrations, metal is taken up by the biofloc through the formation of metal-organic complexes. At higher metal concentrations, metal ion precipitation from solution may occur in addition to sludge uptake. The high molecular weight exocellular polymers of the biofloc, which include polysaccharide, protein, ribonucleic acid, and deoxyribonucleic acid, provide many functional groupings that may act as binding sites for the metals.

Metal uptake by the biomass depends on several factors, including pH and the concentration of organic matter and metals present in the system. Higher initial concentrations of metal ions or sludge increase the overall uptake. In general, the uptake capacity increases with increasing pH, up to a value at which metal hydroxide precipitation occurs. Among the metals studied, the preferred order of uptake by activated sludge was found to be in the sequence of lead > copper > cadmium > nickel.

Although the affinity of the biomass for metal ions is relatively less than for strong chelating agents, it is much higher than that of competing organics in the supernatant. The large-scale accumulation of heavy metals by activated sludge, with its subsequent removal in the secondary clarifier, explains the significant reductions of these metals observed in many plants.

The use of stability constants provides a rational basis for predicting levels of metal accumulation in the sludge and residual effluent metal concentrations.

Cherry, W.B., J.B. Hanks, B.M. Thomason, A.M. Murlin, J.W. Biddle, and J.M. Croom.

Salmonellae as an Index of Pollution of Surface Waters.

Applied Microbiology. 24(2):334-340. 1972.

Key Words: salmonella, bacteria, surface water (fresh).

Abstract:

The state-of-the-art in isolating salmonellae is discussed.

Chester, R. and J.H. Stoner.

The Distribution of Zinc, Nickel, Manganese, Cadmium, Copper, and Iron in Some Surface Waters from the World Ocean.

Marine Chemistry. 2:17-32. May 1974.

Key Words: cadmium, copper, iron, manganese, nickel, zinc, surface water (marine).

Abstract:
The article establishes levels of heavy metals in the marine environment.

Chow, T. and J.L. Earl.

Lead Aerosols in the Atmosphere: Increasing Concentrations.

Science. 169:577-580. September 1970.

Key Words: lead.

Abstract:

The concentrations of atmospheric lead around San Diego, California, are determined, and their geographic and seasonal variations are explained. The aerosol concentration at San Diego is increasing at a rate of 5 percent annually. The isotopic composition of lead aerosols is similar to that of the lead isolated from gasoline, which is one of the largest contributors to atmospheric pollution.

Chow, T.J., C.C. Patterson, and D. Settle.

Occurrence of Lead in Tuna.

Nature. 251:159-161. September 1974.

Key Words: lead, fish.

Abstract:
Measurements of lead levels in tuna (including canned) from various locations is discussed.

CHRIS (Chemical Hazards Response Information System): Hazardous Chemical Data.

U.S. Coast Guard, Washington, D.C. 1974.

Key Words: synthetic /organics, fish, drinking and recreational water, surface water (fresh), surface water (marine).

Abstract:

Hazardous substances which are transported by the Coast Guard and which may accidentally be discharged into water were tested for toxicity to fish and wildfowl. The concentration in ppm at which the chemical was tested is given; the time of exposure in hours; the names of the aquatic species studies; and the OLC_{50} or TL_m; and the kind of water used. Hundreds of compounds from acetaldehyde to hexamethylenetetramine are included. We seem to have data only for chemicals beginning with A-H. Information is in summary form.

Christensen, G.L.

Use of Ozone and Oxygen in Advanced Wastewater Treatment.

JWPCF. 46(8):2054-2055. August 1974.

Key Words: COD, ozonation.

Abstract:
This paper basically discusses costs of ozonation and is of little health effects significance.

Chromium: Medical and Biological Effects of Environmental Pollutants.

Committee on Biologic Effects of Atmospheric Pollutants. National Academy of Sciences. Washington, D.C. 1974.

Key Word: chromium.

Abstract:

This article provides an excellent reference on chromium distribution, industrial uses, and biological interactions. Chromium in nutrition and its effects on health, vegetation, aquatic species, etc. are discussed.

Clark, C.S., E.J. Cleary, G.M. Schiff, C.C. Linnemann, Jr., J.P. Phair, and T.M. Briggs.

Disease Risks of Occupational Exposure to Sewage.

Journal of the Environmental Engineering Division, ASCE. 102(EE2):375-387. April 1976.

Key Words: viruses, bacteria, air, shellfish.

Abstract:

A review of the literature on the risks of disease encountered by WWTP workers is provided. Relatively few studies were available. Reliable information regarding public health implications of exposure to waste waters is contingent on the conduct of more definitive studies. An appropriate epidemiological-sociological study has been undertaken by the authors.

Clark, J.A.

The Detection of Various Bacteria Indicative of Water Pollution by a Presence-Absence (P-A) Procedure.

Canadian Journal of Microbiology. 15(7):771-780. 1969.

Key Words: epidemiology, bacteria.

Abstract:

Results of a previously described presence-absence (P-A) test were compared with those of the membrane filter (MF) technique for detecting fecal coliforms, coliforms, and anaerogenic coliforms in municipal drinking water samples. The P-A test allowed more frequent isolation of these organisms and, when supplemented by simple confirmatory tests, could also indicate the presence of fecal streptococci, green fluorescent pseudomonads, *Aeromonas* species, and *Clostridium perfringens*. In the absence of coliform detection, the occurrence of these other bacterial groups could give warning of unusual fecal or organic pollution.

A comparison of coliform and non-coliform isolates from MF and P-A tests indicated that similar organisms were detected by both methods. The finding of false-positive "sheen" colonies was attributable to the presence of ethyl alcohol in the MF Endo medium. Although organisms giving rise to such colonies were non-coliforms, their presence was suggestive of inadequate water treatment.

Clarke, N.A., E.W. Akin, O.G. Liu, J.C. Hoff, W.F. Hill, Jr., D.A. Brashear, and W. Jakubowski.

Virus Study for Drinking Water Supplies.

JAWWA. 68(4):192-197. April 1975.

Key Words: viruses, drinking and recreational water.

Abstract:

The article discusses the methodology for finding, and the question of whether or not there are, significant numbers of viruses in treated drinking water. It relates viral presence to treatment processes, water source, coliform densities, and zoomicrobe population. A literature review is included.

Cleasby, J.L., D.W. Hubley, T.A. Ladd, and E.A. Schon.

Trickling Filtration of a Waste Containing NTA.

JWPCF. 46(8):1873-1887. August 1974.

Key Words: synthetic/organics, BOD, COD, total organic carbon, trickling filters.

Abstract:

Reduction of NTA (phosphate substitute) by trickling filter is discussed. The authors feel that the variability in NTA biodegradation is more likely caused by the susceptibility of the NTA-consuming species to random changes in their environment, possibly a change in pH or the addition of toxic material. This latter idea would result in random variations similar to the variations observed.

Clegg, D.E.

Chlorinated Hydrocarbon Pesticide Residues in Oysters (_Crassostrea commercialis_) in Moreton Bay, Queensland, Australia, 1970-72.

Pesticides Monitoring Journal. _8_(3):162-166. December 1974.

Key Words: pesticides, DDT, DDD, DDE, shellfish.

Abstract:

A 2-year survey was carried out to monitor levels of DDT, DDD, DDE, and dieldrin in oysters (_Crassostrea commercialis_) in Moreton Bay, Queensland, Australia. Samples were taken at quarterly intervals from eight stations located at or near the mouths of streams entering the bay.

Highest levels of 0.94 ppm DDT, 0.51 ppm DDD, 0.20 ppm DDE, and 0.34 ppm dieldrin were found in July 1970 at the sampling station on the Brisbane River 16 km downstream from the center of Brisbane, a city of 700,000. Maximum values at other stations were substantially lower.

Residue levels varied considerably throughout the 2-year period. Authors attribute this at least in part to seasonal rainfall patterns in the catchment areas.

Cliver, D.O.

Virus Association with Wastewater Solids.

Environmental Letters. November 1975.

Key Words: viruses, surface water (fresh).

Abstract:

The solids produced at an urban wastewater treatment plant, tested semiquantitatively, almost all contained human intestinal viruses. Reoviruses and five or more types of enteroviruses were present. Sludge, digested anaerobically at 30° to 32° C, and grit contained measurable levels of viruses. Until reliable means of inactivating the viruses have been developed and implemented, great care should be taken in disposing of these solids.

Cliver, D.O.

Viruses in Water and Wastewater: Effects of Some Treatment Methods.

In: Proceedings of the Thirteenth Water Quality Conference; Virus and Water Quality: Occurrence and Control, University of Illinois, February 1971. pp. 149-158.

Key Words: viruses, chemical treatment, adsorption/ion exchange.

Abstract:

Enteroviruses were used as models to determine the effects of polycation coagulation and of activated carbon treatment of water and wastewater. The model viruses were not removed significantly by polycations used as primary coagulants. The activated carbon did bind virus, but not to an extent that would insure safe effluents. The technique of labeling model viruses with radioactive phosphorus was found to be useful in such studies, especially for testing primary treatment processes or in circumstances where scaling down a procedure would not introduce significant errors.

Cliver, D.O. and J.E. Herrmann.

Proteolytic and Microbial Inactivation of Enteroviruses.

Water Research. 6(7):797-805. July 1972.

Key Words: viruses, chemical treatment,
disinfection.

Abstract:

These results show that some human enteroviruses (most notably CA-9, of those tested) are susceptible to proteolytic enzymes from various sources, and that others are not. One might try to explain the observed inactivation as something other than hydrolysis of the virus coat protein, but it hardly seems worthwhile.

Some of the bacteria tested were also capable of inactivating CA-9, and perhaps other viruses as well. This effect was not shown to be temperature-dependent, beyond the requirment for temperatures which permit microbial growth. Growth, in turn, was necessary only to allow development of adequate cell numbers. Once these had been attained, neither continued growth, metabolism, nor the further presence of the intact cells themselves was necessary for *Pseudomonas aeruginosa* to inactivate CA-9. Two samples of natural water sustained sufficient growth of *P. aeruginosa* to cause enterovirus inactivation. The ecologic significance of this finding is not yet certain.

It does seem clear that what we have been observing is really inactivation. The possibility that it might be an artefact resulting from some action against the PMK host cells appears to have been ruled out. Adsorption to microbial cells is not the cause of the decrease in infectivity titer: this effect can be caused with cell-free preparations, and ^{32}P in virus does not become cell-associated. The experiments using labeled viruses show that at least some of the virus particle is being dismantled and suggest that a portion of the protein serves as substrate for bacterial growth. Intuitively, one would expect such "virophagy" to occur; however, it seems not to have been reported previously.

Part of the observed inactivation is not enzymatic: some substances of <500 molecular weight are involved. Some of this inactivation may not even be virolytic. Still, it seems certain that there are bacteria in nature which are capable of direct inactivation of enteroviruses in one or more ways. We hope that someday this capability can be exploited in wastewater treatment and reclamation.

Cliver, D.O., K.M. Green, and J. Bouma.

Viruses and Septic Tank Effluent.

Small Scale Waste Management Project, University of Wisconsin, Madison, Wisconsin, 1975. 12p.

Key Words: viruses, surface water (fresh).

Abstract:

Viruses and their effects in wastewater effluents are discussed.

Cobb, H.D., R. Atherton, and W. Olive.

An Ecological Approach to the Problem of Biogradation of Phenolic Wastes.

Trinity University, San Antonio, Texas, Dept. of Biology, July 1974. 81p. (Available from National Technical Information Service (NTIS) as AD-A004 517).

Key Words: synthetic/organics, activated sludge.

Abstract:

Nineteen new strains of bacteria capable of degrading cresol have been isolated and characterized. All are capable of simultaneous metabolism of all three isomers of cresol at concentrations of 900 ppm. Four of the most promising organisms have been subjected to physiological studies to determine optimal and extremes of sewage activity. The following can be stated: (1) Optimal pH 7.3 to 8.3, optimal temperature 35 degrees Centigrade, with some activity at 45 degrees Centigrade, have ability to survive short periods of cresol starvation and upon re-exposure again metabolize cresol as may be seen in field conditions. (2) At least one strain can thrive on cresol concentration of 1450 ppm, which is three times greater than any published reports. (3) All strains appear able to metabolize odichlorobenze, a toxic compound and a problem in treatment of industrial wastes.

Colorado River Bacteriological Survey Parker Strip and Lake Havasu, May 25-29, 1973.

EPA-909/9-73-002, U.S. Environmental Protection Agency, San Francisco, Surveillance and Analysis Division, September 1973. 41p. (Available from National Technical Information Service (NTIS) as PB-240 152).

Key Words: coliforms, salmonella, drinking and recreational water, surface water(fresh),

Abstract:

A bacteriological survey of the Parker Strip - Lake Havasu areas of the Colorado River was conducted jointly by the State of Arizona and the Environmental Protection Agency, Region IX, during the Memorial Day weekend, May 25-29, 1973. Results of the study showed that fecal coliform counts exceeded the levels recommended for primary contact recreation water at Blue Water Marina and Buckskin Mountain State Park. Disease-causing bacteria (Arizona group, Salmonellae) were recovered from the Buckskin treatment plant. Included is a photograph of people swimming and playing next to this effluent pipe. Photographic evidence documents ponding of liquid over the septic tank leach fields during a peak-use period at Crazy Horse State Park.

Colston, N.V., Jr.

Characterization and Treatment of Urban Land Runoff.

EPA-670/2-714-096, North Carolina Water Resources Research Institute, Raleigh, December 1974. 170p. (Available from National Technical Information Service (NTIS) as PB-240 987).

Key Words: COD, phosphates, suspended solids, total organic carbon, aluminum, chromium, cobalt, copper, iron, lead, manganese, zinc, coliforms, chemical treatment, effluent characteristics.

Abstract:

The annual urban runoff pollutant yield during the 1972 calendar year from each acre drained was found to be 938 pounds COD, 187 pounds TOC, 7700 pounds total solids, 1458 pounds total volatile solids, 6691 pounds suspended solids, 797 pounds volatile suspended solids, 6.1 pounds kjeldahl nitrogen, 4.7 pounds total phosphorus, 64 pounds aluminum, 52 pounds calcium, 1.9 pounds cobalt, 1.6 pounds chromium, 1.6 pounds copper, 102 pounds iron, 71 pounds magnesium, 4.9 pounds manganese, 1.2 pounds nickel, 2.9 pounds lead, and 2 pounds of zinc.

During wet periods (approximately 20 percent of the 1972 calendar year) the yield of organics measured as COD in urban runoff was approximately 4 ½ times the organic yield of raw sewage while the suspended solids yield in urban runoff was approximately 100 times that in the raw sewage.

Alum, with or without coagulant aids, was judged the most effective coagulant in COD, suspended solids, and turbidity removal. Average removal efficiencies, based on jar test results with alum, indicated 84, 97 and 94 percent of the COD, suspended solids, and turbidity, respectively, could be removed with an average dose resulting in an initial concentration of 50 to 60 mg/l.

Colwell, R.R.

Numerical Analysis in Microbial Identification and Classification.

Developments in Industrial Microbiology. 11:154-160. 1969.

Key Words: surface water (fresh), surface water (marine).

Abstract:

This paper presents microbial identification and classification.

Colwell, R.R.

Occurrence and Biology of *Vibrio parahaemolyticus*.
(Personal Communication).

Key Words: viruses, surface water (fresh), surface water (marine).

Abstract:

V. parahaemolyticus is an estuarine bacterium which demonstrates interesting biological associations with planktonic and benthic organisms. The distribution of *V. parahaemolyticus* in nature appears to be restricted by such environmental parameters as temperature and salinity, with over-wintering occurring in sediments and in or on benthic organisms. *V. parahaemolyticus* appears to be commensal not only to plankton but also to the blue crab, the latter situation thus posing a potential public health hazard.

Colwell, R.R. and F.M. Hetrick.

Survival of Human Pathogens in the Marine Environment.

University of Maryland, College Park, Dept. of Microbiology, July 1975. 26p. (Available from National Technical Information Service (NTIS) as AD-A012 489).

Key Words: coxsackie virus, ECHO viruses, polio virus, surface water (marine).

Abstract:

It is apparent from the results of the virus studies that enteric viruses survive for relatively long periods of time in estuarine and marine salinities when the water temperature is 25 C or lower. Of the three enterioviruses tested, Coxsackie B-5 virus has been the most stable one with ECHO-6 virus being intermediate and polio 1 the least stable virus. This was true both in controlled laboratory experiments and *in situ* and is probably indicative of the diversity in stability one would encounter if all of the 100+ human enteroviruses were studied. While the salinity of the water may have minor effects on enterovirus stability, clearly the most important factor affecting virus viability was the temperature of the water.

Since the Navy is considering installation of some type of on-shipboard sewage treatment facility, the sensitivity of enteroviruses to higher temperatures is an area that should be investigated more thoroughly. Indeed, we plan to conduct studies during the current and ensuing contract periods into the kinetics of enterovirus inactivation at pasteurization temperatures using selected viruses and waters of various salinities. Also of interest to us is the preliminary indication that seawater may have an innate virucidal activity. By necessity, all of our survival studies to date have been conducted under conditions that are not "natural" although our *in situ* studies do allow direct exposure of the viruses to estuarine waters and their components. We plan to conduct similar *in situ* studies on enterovirus survival using free-flowing ocean water--indeed, these studies have already been initiated in July 1975 at the University of Delaware laboratories at Lewes. Also, ocean water samples will be directly seeded with enteroviruses and held at 4, 15, and 25 C and virus inactivation rates studied. If virucidal activity is detected we will attempt to characterize the active principle.

During the first year of the contract, we made numerous attempts to isolate enteroviruses directly from estuarine and marine waters without success. We did not expect to isolate agents from most of the water samples since they were taken from relatively clean areas, however, two samples taken from polluted areas, one in Baltimore Harbor and one near the outfall of the Annapolis sewage treatment plant, were also negative. We will continue to use the Amicon dialysis unit for processing estuarine water samples but the concentrates will be used primarily for bacteriological rather than virological studies.

The results obtained from our *in situ* survival studies of selected bacteria have not been consistent. Unlike viruses which do not multiply outside of living cells and hence can be expected to decrease in numbers with time, even when nutrient levels are high, the bacteria are living cells and thus are influenced directly by the nutrient load in the waters to which they are exposed. In contrast to the viruses, the bacteria seem to survive better at high rather than low water temperatures. For future bacterial survival studies, we plan to change our experimental design from suspension of the organisms in dialysis bags to seeding of water in tanks which will have a recirculation system. Hopefully, this approach will more nearly approximate natural conditions for these organisms.

Colwell, R.R., T.C. Wicks, and H.S. Tubiash.

A Comparative Study of the Bacterial Flora of the Hemolymph of Callinectes sapidus.

Marine Fisheries Review. 37(5-6):29-33. May-June 1975.

Key Words: bacteria, surface water (marine).

Abstract:

The bacterial flora of blue crabs (Callinectes sapidus) from Chesapeake Bay was examined. Hemolymph of normal, healthy blue crabs was found non-sterile, with total bacterial counts ranging from <100 to $>3.0 \times 10^5$ on a seawater-based medium and 0 to $>10^5$ on Standard Methods Agar. Counts of $0\text{-}10^3$ were observed on TCBS agar. Vibrio spp., including Vibrio parahaemolyticus, were the major taxonomic groups found in the crab hemolymph. A comparison of crab data with that of Chesapeake Bay oysters revealed a qualitative difference in that the crab hemolymph flora was almost entirely Vibrio spp., whereas the oyster flora included species of a variety of other genera.

Colwell, R.R., T. Kaneko and T. Staley.

Vibrio parahaemolyticus - An Estuarine Bacterium Resident in Chesapeake Bay.

In: Food-Drugs from the Sea; Proceedings of the 1972 Marine Technology Society Conference. pp. 87-94.

Key Words: bacteria, surface water (marine).

Abstract:

Microbial ecology studies of Chesapeake Bay were initiated in our laboratory in 1964. Since that time, analyses of seasonal and regional differences in the microflora, specifically the bacteria, were undertaken and, in the first three years of the past nine years of research, two areas of Chesapeake Bay were studied intensively, with samples of water, sediment and oysters collected at six-week intervals. Bacteriological analyses were done, in the earliest stages of the research, immediately upon retrieval of the samples. However, subsequent studies that were carried out showed that the 3-6 hour delay from the time of sampling until return to the laboratory for analysis did not affect the results, provided the samples were kept iced. The two areas of Chesapeake Bay, Marumsco Bar, near Crisfield, Maryland, on the lower Eastern Shore and Eastern Bay, on the upper Eastern Shore of Maryland, were subjected to careful bacteriological analysis. Marumsco Bar suffers annual mortalities of the shellfish population and is no longer a highly commercially productive area for oysters, whereas Eastern Bay remains a thriving oyster harvesting area.

These two sites provided a useful comparative study in microbial ecology. The results to date indicate that, although the total microbial populations in the water column, sediment, and oysters are roughly the same, the genetic constitution of the bacterial populations associated with the two areas are very different. Vibrio spp. are found in significantly greater numbers in the Marumsco Bar sites.

Colwell, R.R., T. Kaneko, T. Staley, M. Sochard, J. Pickar, and L. Wan.

Vibrio parahaemolyticus - Taxonomy, Ecology, and Pathogenicity.

In: Proceedings of the International Symposium on *Vibrio parahaemolyticus*, Tokyo, Japan, September 1973. pp. 169-176.

Key Words: viruses, *Vibrio cholerae*, surface water (marine).

Abstract:

In 1969 *Vibrio parahaemolyticus* was discovered in Chesapeake Bay by Krantz, Colwell and Lovelace. Lovelace, Tubiash and Colwell established that *Vibrio* spp. are a dominant portion of the natural microbial flora in Chesapeake Bay. Sizemore, Tubiash and Colwell found *V. parahaemolyticus* in the hemolymph of healthy blue crabs. Taxonomic studies of *V. parahaemolyticus* reveal a very close relationship of U.S. and Japanese strains of *V. parahaemolyticus* but a lower relationship of *V. parahaemolyticus* strains with *Vibrio cholerae*. At least three nodes of related strains have been recognized within the genus *Vibrio* as presently classified: *V. cholerae*; *V. parahaemolyticus*; and marine vibrios.

The incidence of *Vibrio parahaemolyticus* and related vibrios in Chesapeake Bay was correlated with water temperature. Vibrios could not be detected in the water column during the winter, although they were present in the sediments.

Pathogenicity of *V. parahaemolyticus* was examined using LD_{50} in Balb/c mice and ability to induce fluid accumulation in ligated ileal loops of rabbit intestine. Endotoxins were extracted and tested in rabbits for reactivity in the dermal Shwartzman test, pyrogenicity, tolerance induction, cross-tolerance induction to endotoxin from *Salmonella typhi*, heat stability; induction of fluid accumulation in ligated intestinal loops and permeability factors. A fraction, which exhibited some properties of an enterotoxin, was compared with enterotoxin from *V. cholerae*. Hyperimmune reference antisera was prepared and immunological cross-reaction determinations were done using agar gel double diffusion and passive hemagglutination.

Comer, S.W., D.C. Staiff, J.F. Armstrong, and H.R. Wolfe.

Exposure of Workers to Carbaryl.

Bulletin of Environmental Contamination and Toxicology.
13(4):385-391. April 1975.

Key Word: epidemiology.

Abstract:

The article reports results of studies of potential dermal and respiratory exposure of formulating plant workers and spraymen to carbaryl, as well as urinary excretion of 1-Naphthol by certain formulating plant workers.

Committee on Public Health Activities.

Coliform Organisms as an Index of Water Safety.

Journal of the Sanitary Engineering Division, ASCE.
87(SA6):41-58. November 1961.

Key Words: viruses, hepatitis virus, coxsackie virus.

Abstract:

In spite of questions and suggestions for a substitute test there is at present no justifiable basis for changing the bacteriological criteria for water supply safety and no need for serious concern with the safety of a water supply which fully meets USPHS Drinking Water Standards.

Experiences with infectious hepatitis outbreaks and laboratory data lend support to the already generally accepted principal there may be a serious health hazard created by accepting "marginal treatment" of water supplies, especially those subject to sewage contamination.

Because infectious hepatitis virus survive all normal steps in water treatment except proper free residual chlorination and since viruses survive heavy doses of combined chlorine, the practice of providing free chlorine residual treatment with adequate contact is important, especially when a water supply is known to have been subject to fecal contamination.

Congenital Malformations Surveillance.

Birth Defects Monitoring Program. Metropolitan Atlanta, Nebraska, Florida. January-December 1975. U.S. Department of Health, Education, and Welfare. June 1976.

Key Word: epidemiology.

Abstract:

The article contains summarized data concerning infants with congenital malformations as ascertained by four surveillance programs.

Cookson, J.T.

The Chemistry of Virus Concentration by Chemical Methods.

Developments in Industrial Microbiology. 15:160-173. 1973.

Key Words: viruses, chemical treatment.

Abstract:

The concentration of viruses from dilute solution depends on physical and/or chemical parameters. Before any chemical interactions occur, a physical or transfer step must take place. Since physical transfer is easily optimized, efficiency of concentration is usually influenced greatly by the chemical step. This paper attempts to provide a better understanding of these chemical interactions. Chemical methods for concentrating viruses from water solutions include adsorption onto aluminum hydroxide, aluminum phosphate, calcium hydrogen phosphate, protamine sulfate, iron oxide, polyelectrolytes, and liquid-liquid partitioning. Understanding the basic chemical mechanisms involved in each concentration procedure is important for optimizing adsorption and release of viruses. Available data from numerous studies are analyzed for each method. This information is interpreted in terms of the chemical characteristics of the aqueous phase and the surface characteristics of the virus and adsorbing solid. Although more information is needed before the complete chemical mechanisms of virus concentration can be proposed, general conclusions are made and several specific mechanisms are proposed.

Cookson, J.T.

Mechanism of Virus Adsorption on Activated Carbon.

JAWWA. 61(1):52-56. January 1969.

Key Words: viruses, adsorption/ion exchange.

Abstract:

This study was undertaken to provide a better understanding of colloid removal in filter beds. The influence of physical parameters is evaluated and a model presented to correlate physical filtration parameters to removal efficiency. Removal of the virus Escherichia coli bacteriophage T_4 is studied in packed beds of activated carbon. The chemical characteristics of the system are maintained at optimum conditions for virus attachment, while the physical characteristics are varied. Virus removal is interpreted by a physical model based on particle transport by diffusion in a flowing fluid. Virus removal closely follows the transfer model, which can be used to predict the effects of flow rate, bed height, void volume, and bed grain size on removal efficiency.

In summary, under optimum adsorption conditions, virus removal in packed beds of activated carbon closely followed mass transfer theory. Colburn factor, j, varied with fractional void volume of the bed, but was constant if the void fraction corrections of Pfeffer and of 1/e were applied. Colburn factor also varied with bed heights. Greater deviation from theoretical equations occurred with longer column heights. This phenomenon is probably due to improper representation of the concentration profile through the column.

From this study, it appears that the particle transport mechanism in filtration can be described by application of the mass transfer theory when diffusion is the limiting process for removal. Application of mass transfer with information on isothermal adsorption may eliminate the effect of column height.

Cookson, J.T.

Removal of Submicron Particles in Packed Beds.

Environmental Science and Technology. 4:128-134.
February 1970.

Key Words: bacteria, viruses, filtration.

Abstract:

Sites on activated carbon that adsorb bacteriophage T_4 are probably a carboxyl group or lactone. Adsorption on carbon can be completely blocked by esterifying these groups.

It is proposed that amino groups on the virus adsorb to carboxyl groups on the carbon by electrostatic attraction. The pH range of strong adsorption rules out participation by ionized forms of sulfhydryl, guanidino, and phenolic groups in the electrostatic binding. Ionized imidazolyl groups are probably too few to be significant.

As pH decreases from the optimum of 7, adsorption rate decreases, probably as a result of viral tail fibers being attached to the tail sheath, making them unavailable for attachment to carbon sites.

At pH values higher than optimum, the tail fibers of bacteriophage T_4 are extended. The observed decrease in adsorption rate presumably resulted from an increase of negative charge on the virus particles and carbon surface, causing greater repulsive forces between viruses and carbon particles. The collision frequency, therefore, was reduced.

Electrostatic binding of virus and carbon, and designation of viral tail fibers as the adsorbing units, received support from the effect of ionic strength on adsorption. With increasing ionic strength, adsorption is aided as like charges on the virus and carbon particles are masked; at the same time, repulsive forces between the viral tail fibers and tail sheath are reduced. With increasing ionic strength, more and more tail fibers adsorb on the tail sheath. Although high ionic strengths cause a maximum collision frequency between virus and carbon particles, the adsorbing tail fibers become less available. These mechanisms are suported by equilibrium studies at high and low ionic strengths.

Cookson, J.T. and W.J. North.

Adsorption of Viruses on Activated Carbon: Equilibria and Kinetics of the Attachment of _Escherichia_ _Coli_ Bacteriophage T_4 on Activated Carbon.

Environmental Science and Technology. _1_(1):46-52. January 1967.

Key Words: _Escherichia_ _coli_, viruses, adsorption/ion exchange.

Abstract:

Information is needed about the removal of viruses in waste treatment and water purification. Virus removal has been described as adsorption in the activated sludge, flocculation, and filtration processes. Adsorption of _Escherichia_ _coli_ bacteriophage T_4 on activated carbon was studied in an agitated solution containing virus and carbon under controlled conditions of temperature, pH, ionic composition, and reactant concentrations. Surface area and particle size distribution were established for the activated carbon. The kinetics of bacteriophage T_4 adsorption on activated carbon can be described by a reversible second-order equation, first-order with respect to both virus and carbon concentration. Adsorption obeys the Langmuir isotherm and is reversible. Virus is not inactivated by adsorption. Adsorption is unimolecular, with very inefficient use of the available carbon surface area, and is of a physical nature and independent of temperature. The virus is probably completely excluded from pores because of its size.

Cooper, B.S. and R.C. Harris.

Heavy Metals in Organic Phases of River and Estuarine Sediment.

Marine Pollution Bulletin. 5(2):24-26. February 1974.

Key Words: cadmium, chromium, copper, iron, lead, manganese, nickel, zinc, surface water (fresh).

Abstract:

In the least polluted sediment (E), contents of metals in organic fractions were quite high when compared with the mineral fractions, although the metals seem to be restricted to the total organic (which was 90% nonsoluble organic matter), the humic, and the asphalt fractions. There was an association of Zn, Ni and Cu with asphalts, and Cu and Zn with the humic acids but the low concentration of Zn in the total organic fraction, compared with the soluble fractions, shows that some loss of Zn by acid hydrolysis had occurred.

Further downstream at sample point (D), below the point at which treated sewage effluent mixed with acid water from a stream draining colliery waste, there was visible precipitation of iron and aluminum hydroxides in the river, and the heavy metal content of the sediment was generally much increased. The total organic matter also showed increased concentrations of Fe, Cu, Zn, Pb, Cr and Cd and among the soluble organic fractions, the lipids had much increased metal contents.

The effect of the oxide precipitation was much diminished for the sample (C), indeed the total organic matter contained rather depleted amounts of metal except for Fe and Ni, but the Cu and Zn contents of the soluble organic fractions showed that there may have been some acid hydrolysis of these metals during isolation of the total organic fraction. Metal distributions in sample (B) were similar to those of (E) and (C), although the Zn content of the total organic matter was much higher than previously seen.

The sediment (A), taken at the most polluted site, again contained high metal contents for the total organic matter, although except for Ni in the humic acid fraction, the soluble organic fractions were rather depleted in metal content. This sediment had a high organic content (14%) and the contributions by the organic matter of Zn (8%). Pb (15%), Ni (22%) and Cd (60%) to the metal in the sediment must be of some significance. Under the microscope, it could be seen that some of this organic matter was coal dust, but an analysis of similar coal in lump form showed that it was not itself a significant source of metals.

The isolation of the actual organic complexing agents is difficult, but during one chromatographic separation it was possible to isolate a green pigment fraction (from Df) which contained 700 ppm Cu, 340 ppm Mn and 1,000 ppm Fe.

Overall, it appears that the distribution of metals as organic complexes in sediment is very sensitive to environmental factors, but even in this lightly polluted river the following concentrations can be reached: Fe (10,000 ppm); Mn (2,200 ppm); Zn (800 ppm); Cu (700 ppm); Ni (230 ppm); Pb (100 ppm); Cr (30 ppm); Cd (15 ppm).

Copeland, B.J.

Effects of Industrial Waste on the Marine Environment.

JWPCF. 38(6):1000-1010. June 1966.

Key Words: ammonia, nitrates, nitrites, phosphates, surface water (fresh).

Abstract:

Water quality characteristics of St. Joseph's Bay, Florida, a bay heavily polluted by industrial effluents, were used to show the effects of industrial pollution on a marine estuary. The effects demonstrated are as follows:

1. Reducing-type environments were indicated by both redox potentials and Ohle anomalies near the industrial effluent outfall, with decreasing effects as distance from the outfall increased.

2. Species diversity was less near the entrance of the effluent and greater as distance increased.

3. Concentration of phosphorus near the effluent entry point was more than 10 times that in normal bay water.

4. Measurements of metabolic rates of fishes in various industrial wastes indicated rates greater than normal, even though the effluent was not toxic to the fish.

5. Studies of community metabolism indicate that holding the effluent a number of days for biochemical action improves the quality of the aquatic community receiving the effluent.

Copenhaver, E.D. and B.K. Wilkinson.

Transport of Hazardous Substances through Soil Processes.
Vol. I: Arsenic, Beryllium, Cadmium, Chromium, Copper, Cyanide, Lead, Mercury, Selenium, Zinc, and Others.
Vol. II: Pesticides.

ORNL-EIS-74-70, Oak Ridge National Laboratory, Oak Ridge, Tennessee,November 1974.

Key Word: bibliography.

Abstract:
These are bibliographies only.

Cortinovis, D.

Activated Biofilter: A Modesto Invention Gains Acceptance throughout North America.

The Bulletin (California Water Pollution Control Association). 12(2):38-41. October 1975.

Key Words: COD, trickling filters.

Abstract:

This paper discusses a process which is an offshoot of the trickling filter process producing BOD removals of 60 to 65%.

Cottrell, N.M.

Disposal of Municipal Wastes on Sandy Soil: Effect on Plant Nutrient Uptake.

Oregon State University, Corvallis, 1975. 201p.

Key Words: arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, tin, zinc, ammonia, BOD, chlorides, nitrates, nitrites, phosphates, bacteria, agriculture, crops.

Abstract:

Solid municipal waste and sewage sludge were applied to land, and three crops were planted. Plant content of N, P, S, Ca, Mg, K, Fe, and Cu were not affected by the waste treatments. Mn and Zn uptake increased with waste addition and with nitrogen fertilization.

Counts, C.A., A.J. Shuckrow, and J.E. Smith.

Stabilization of Municipal Sewage Sludge by High Lime Dose.

In: Pretreatment and Ultimate Disposal of Wastewater Solids. A. Freiberger, ed. EPA-902/9-74-002, Environmental Protection Agency, New York, Region II, May 1974. pp. 73-125.

Key Words: salmonella, fecal streptococci, coliforms, lime treatment.

Abstract:

A process for producing lime stabilized sludge was developed and operated successfully at pilot scale. Significant reductions in pathogen populations and obnoxious odors resulted from lime treatment. Growth studies, both in a greenhouse and on outdoor plots, indicate that disposal of lime stabilized sludge on cropland would have no detrimental effects.

Cranston, R.E., and D.E. Buckley.

Mercury Pathways in a River and Estuary.

Environmental Science and Technology. 6:274-278. March 1972.

Key Words: mercury, surface water (fresh).

Abstract:

A method for measuring total mercury in water, suspended particulate matter, and bottom sediments has been evaluated. Some data have been applied to a study of the geochemical pathways of mercury in a rural river and estuary system. Concentrations of mercury in the LaHave River (Nova Scotia) are related to the proximity of a small rural town. The dissipation of mercury in solution appears to be through dilution, as well as by adsorption on suspended particulate matter which raises the level in particulate matter to the range of 2.04-34.4 ppm. Bottom sediments in the LaHave River are affected by sedimentation of particulate matter containing high levels of mercury, but the mercury concentration in the bottom sediments ranges from 0.09 to 1.06 ppm. Mercury released to the natural environment from industrial waste effluents appears to be discharged mostly in the dissolved form but may be quite rapidly adsorbed as shown by analyses of suspended particulate matter and bottom sediments.

Craun, G.F.

Microbiology - Waterborne Outbreaks.

JWPCF. 47(6):1566-1581. June 1975.

Key Word: epidemiology.

Abstract:

This is a review article on waterborne outbreaks in the U.S. in 1973. There were 24 waterborne disease outbreaks involving 1,720 cases of illness in the U.S. in 1973 including: amoebic meningoencephalitis, cholera, dracontiasis, gastroenteritis, giordiasis, leptospirosis, schistosomiasis, shellfish poisoning, shigellosis, typhoid fever, salmonellosis, and V. parahaemolyticus gastroenteritis.

An extensive list of related literature published in 1973-1974 is also included.

Craun, G.F. and L.J. McCabe.

Review of the Causes of Waterborne-Disease Outbreaks.

JAWWA. 65(1):74-84. January 1973.

Key Words: epidemology, wastewater treatment processes.

Abstract:
The emphasis of this article is on deficiencies in water supply systems and operational procedures that allow disease outbreaks to occur.

Crites, R.W.

Irrigation with Wastewater at Bakersfield, California.

In: Wastewater Use in the Production of Food and Fiber-Proceedings. EPA-660/2-74-041, U.S. Environmental Protection Agency, Washington,D.C., Office of Research and Development, June 1974. pp. 229-239.

Key Words: ammonia, BOD, nitrates, chlorides, phosphates, total dissolved solids, salmonella, groundwater,crops.

Abstract:

Merz reported that no diseases have been traced to effluent use, although there have been problems with flies and mosquitoes. The current superintendent of the city's treatment plants reiterated that no diseases have been associated with the operation. Mosquitoes are a problem wherever water is allowed to pond and stagnate, so that keeping the excess water moving is a major management problem. The two equalizing reservoirs (5 and 10 acres in size) and the storage pond for tailwater are periodically sprayed to control mosquito propagation.

Current public health regulations for irrigation of fodder, fiber, and seed crops are that the quality of reclaimed water shall be equivalent to primary effluent. No disinfection of the effluent is required, and none is provided at the two plants. Dairy cows are not allowed to graze pastures irrigated with nondisinfected effluent; however, beef cattle are not restricted.

A complaint by the Regional Water Quality Control Board that the irrigation operation was contaminating the groundwater with nitrates led to an investigation of the ground water quality. Six shallow wells were drilled and sampled in late 1972. Perched water was found at the 11- to 12-foot depth in 3 wells and not at all in the other 3 wells (drilled 30 feet deep). Nitrate concentrations ranged from 4 mg/l as nitrate in the center of the farm to more than 600 mg/l nitrate directly beneath the old site of the sludge drying beds at the Mount Vernon plant.

The Regional Board conducted a sampling program in September 1971 and found nitrate concentrations ranging from 0.4 mg/l to 68 mg/l as nitrate. These wells were along the western edge of the farm, which is in the direction of flow of the unconfined acquifer. These wells were sampled at depths of 80 to 170 feet.

No firm conclusions relating effluent irrigation to groundwater nitrate levels could be drawn from either investigation. The confined aquifer below the farm (300 feet deep) has nitrate concentrations of 50 to 60 mg/l as nitrate. However, many wells, both deep and shallow throughout the Bakersfield area have high nitrate and TDS concentrations. The groundwater hydrology of the area is complex and groundwater quality is influenced not only by irrigation practices, but also by oilfield well injections, natural occurrences of salt, and cattle feedlots. A more detailed investigation of groundwater quality is in the planning stage for 1975.

Cropper, J.B. and L.F. Welch.

Greenhouse Studies.

In: Agricultural Benefits and Environmental Changes Resulting from the Use of Digested Sewage Sludge on Field Crops. T.D. Hinesly, ed. pp. 13-14. 1971.

Key Words: copper, zinc, ammonia, nitrates, phosphates, agriculture.

Abstract:
The following observations were made:

1. Sludge will provide adequate amounts of nitrogen, phosphorus, and potassium at the rate of 0.5 acre-inch per week during the growing season.

2. Sludge at the rate of 6 inches annually perhaps adds too much nitrogen.

3. Application of liquid digested sludge immediately after planting should probably be avoided unless not more than 0.5 acre-inches is applied.

4. Zinc and copper concentrations in corn are increased substantially by sludge fertilization. These metals could build up to toxic levels in the soils if sludge is applied at high rates for many years.

5. Sludge does not seem to have much effect on soil pH on a short-term basis.

6. Cation exchange capacity and buffering capacity of sandy soils is increased considerably by sludge applications.

7. Liming of sludge treated acid soils would be desirable for many reasons. It would tend to keep the heavy metals less soluble. Manganese, in particular, would be reoxidized by the increased pH of the soil so that it would not leach from the upper profile of the soil. Lime would promote more rapid nitrification of the tremendous amounts of ammonium nitrogen present in the soils after sludge additions.

Cross, F.A., L.H. Hardy, N.Y. Jones, and R.T. Barber.

Relation between Total Body Weight and Concentrations of Manganese, Iron, Copper, Zinc, and Mercury in White Muscle of Bluefish (*Pomatomus saltatrix*) and a Bathyl-Demersal Fish *Antimora rostrata*.

Journal of the Fisheries Research Board of Canada. 30:1287-1291. September 1973.

Key Words: copper, iron, manganese, mercury, zinc, fish.

Abstract:

Concentrations of mercury (Hg) increased significantly with size ($P < 0.001$) in white muscle of bluefish (*Pomatomus saltatrix*) and a bathyl-demersal fish *Antimora rostrata*, but concentrations of manganese (Mn), iron (Fe), copper (Cu), and zinc (Zn) either remained constant or decreased. These results indicate that fish residing in two different ecosystems in the Atlantic Ocean may be in a steady state with their environment with respect to Mn, Fe, Cu, and Zn but not Hg. The observed variations in accumulation patterns of trace metals in muscle of these two species as a function of size are discussed.

Crump-Wiesner, H.J., H.R. Feltz, and M.L. Yates.

A Study of the Distribution of Polychlorinated Biphenyls in the Aquatic Environment.

U.S. Geological Survey Journal of Research. 1:603-607. September 1973.

Key Words: pesticides, chlorinated hydrocarbons, direct contact (air), surface water (fresh).

Abstract:

Data gathered from monitoring activities and project studies indicate the ubiquitous occurrence and distribution of polychlorinated biphenyls (PCB's) in the aquatic environment. By 1972 residues had been detected in samples from 19 States representing nearly every region of the country. These findings permit a preliminary assessment of PCB contamination across the nation: concentrations ranged from 0.1 to 4.0μ g/liter in unfiltered water samples and from 5.0 to 3,200μ g/kg in bottom sediments. PCB residues were also found in fish and aquatic plants. Samples were prepared by the same techniques used for general chlorinated insecticide detection, with special attention to cleanup and separation of PCB's from other compounds. Basic identification and quantification were made by dual-column electron-capture/gas-liquid chromatography and confirmed by gas-liquid chromatography/mass spectrometry whenever possible. In sediment samples from a south Florida drainage ditch, polychlorinated naphthalenes (PCN's) were observed. This is possibly the first evidence of PCN's in an environmental sample and illustrates the importance of developing analytical capability for the surveillance of other organo-chlorine compounds that may behave like chlorinated hydrocarbon pesticides.

The sampling program is broadening geographically and gradually increasing to more adequately define the distribution of PCB residues in major drainage basins of the United States.

Cruver, J.E. and I. Nusbaum.

Application of Reverse Osmosis to Wastewater Treatment.

JWPCF. 46(2):301-311. February 1974.

Key Words: ammonia, BOD, COD, phosphates, total dissolved solids, activated sludge, chemical treatment, adsorption/ion exchange.

Abstract:

Reduction effects for the Los Angeles County pilot plant at Pomona are described.

Culbertson, C.G.

The Pathogenicity of Soil Amebas.

Annual Review of Microbiology. 25:231. 1971.

Key Words: epidemiology, protozoa.

Abstract:

Investigations into the natural habitat and ecology of amebas such as *N. aerobia* are just beginning, and as yet, no solid information is at hand. Lakes and pools from which infections appear to have come should be studied carefully. The question of the effect of pollution by sewage, nitrogen fertilizer, or pesticides, either directly or by causing decay of vegetation is of concern. These elements could influence the growth of amebas.

Culp, G.L. and A.J. Shuckrow.

Physical-Chemical Techniques for Treatment of Raw Wastewaters.

Public Works. 103(7):56-60. July 1972.

Key Words: BOD, COD, suspended solids, chemical treatment, adsorption/ion exchange.

Abstract:
The reduction of basic parameters using physical-chemical and carbon adsorption treatment is described.

Culp, G.L., R.L. Culp, and C.L. Haman.

Water Resource Preservation by Planned Recycling of Treated Wastewater.

JAWWA. 65(10):641-647. October 1973.

Key Words: biological cotaminants, drinking and recreational water.

Abstract:

The proposed AWT plant at Montgomery County, Md., and the AWT plant being designed for the Upper Occoquan Sewage Authority will be outstanding examples of water-resource preservation by planned indirect recycling of treated wastewater. Both plants will make maximum utilization of the best available practical processes for biological, physical, and chemical treatment plus subsequent natural purification in an effluent reservoir and in the receiving water.

The effluent from the AWT plants will be of better quality in most respects than that of the Potomac River or the Occoquan Reservoir. Effluent quality is of paramount importance because both plans for recycling involve drinking-water supplies. Therefore, maximum assurance of safety is necessary in treatment of the wastewater for reuse. Thus, the treatment process must effectively remove heavy metals, trace organics, and all pathogenic organisms.

Culp, R.L.

Breakpoint Chlorination for Virus Inactivation.

JAWWA. 66:699-703. December 1974.

Key Words: viruses, chlorination.

Abstract:

This paper discusses virus removal but does not specify specific organisms beyond virus. Data are sketchy but indicate complete virus removal.

Culp, R.L.

Breakpoint Chlorination for Virus Inactivation.

In: Virus Survival in Water and Wastewater Systems. J.F. Malina, Jr. and B.P. Sagik, eds. University of Texas at Austin, Center for Research in Water Resources, 1974. pp. 158-165.

Key Words: viruses, chlorination.

Abstract:

Chlorination is the major tool available to prevent control of the spread of viral disease. Certain pathogenic virus may be present in wastewater. In controlling public health problems from this source, three barriers are available or can be created, consisting of AWT, natural purification, and water treatment. Chlorination can be a bulwark in two of these three lines of defense. As already pointed out, conventional secondary treatment of wastewaters even with chlorination does not assure complete removal of virus. However, advanced wastewater treatment (AWT) methods, which include chlorination as a principal element, are already developed, demonstrated, and proven at full plant scale which can completely and consistently inactivate all virus. There is no longer any need to discharge virus in wastewater either to the land or to the nations's water sources. Virus can be removed before the water is released. This is barrier number one. Even though AWT processes are being installed at a much greater rate than anyone anticipated 13 years ago when the research and development of these methods were initiated, it is not likely that AWT systems will ever be applied to all wastewaters.

Undoubtedly, most wastewaters will continue to be discharged to land or water with their virus content only partially diminished. Fortunately, anywhere outside the human body pathogenic viruses are in a hostile environment. Prolonged storage (30 days) of water, or percolation of water through fine soil will effect substantial, but possibly not complete, removal of virus from wastewater. Such exposure provides a second line of defense against waterborne virus disease.

Culp, R.L.

Disease Due to "NonPathogenic" Bacteria.

JAWWA. 61(3):157. March 1969.

Key Words: bacteria, epidemiology.

Abstract:
A commentary article on the water works practices as they relate to the gram-negative bacteria such as *Pseudomonas aeruginosa* and *E. coli*, the article comments on the involvements of these bacteria in a hospital nursery.

Culp, R.L.

Virus and Bacteria Removal in Advanced Wastewater Treatment.

Public Works. 102:84-88. June 1971.

Key Words: viruses, bacteria, adsorption/ion exchange, chlorination.

Abstract:
Removal of virus and bacteria using carbon adsorption and chlorination is discussed and sampling results presented.

Culp, R.L.

Wastewater Reclamation at South Tahoe Public Utilities District.

JAWWA. 60(1):84-94. January 1968.

Key Words: ammonia, BOD, COD, nitrates, nitrites, phosphates, total organic carbon, viruses, coliforms, chemical treatment.

Abstract:

There is an increasing need for more and better treatment of wastewater. Wastewater treatment makes possible a higher effluent quality, aesthetically and technically, than can be obtained by conventional processes. It removes suspended and colloidal matter, color, odor, organic chemicals, and other substances that remain after conventional treatment. Wastewater treatment is effective against bacteria, viruses, toxic chemicals, and other health hazards and reduces eutrophication of lakes and ponds and other threats to the natural environment. Efficient treatment of wastewater is the key to wastewater reclamation, a promising, if still virtually unexploited method of alleviating deficiencies in many types of water utilization. Today, wastewater reclamation is economically and technologically practicable.

The Tahoe water reclamation process is one approach to filling some of these needs. It is not the only approach, but many of the unit processes employed can be applied usefully elsewhere.

Cunningham, P.A. and M.R. Tripp.

Accumulation and Depuration of Mercury in the American Oyster _Crassostrea_ _virginica_.

Marine Biology. _20_:14-19. May 1973.

Key Words: mercury, shellfish.

Abstract:

This paper discusses the accumulation of Hg in oysters. Gains of 2800 times were found.

Dahling, D.R., G. Berg, and D. Berman.

BGM, A Continuous Cell Line More Sensitive than Primary Rhesus and African Green Kidney Cells for the Recovery of Viruses from Water.

Health Laboratory Science. 11:275-282. 1974.

Key Words: epidemiology, viruses.

Abstract:

A continuous cell line, BGM, derived from primary African green monkey kidney cells, was more sensitive than primary rhesus or African green monkey kidney cells to many enteroviruses and to reovirus 1. Comparative tests in BGM cells and in primary rhesus kidney cells showed that many enteroviruses and reovirus 1 multiplied to higher titers in BGM cells even after the viruses had been adapted to primary monkey kidney cells or to Vero cells.

In comparative studies with sewage, sewage effluents, and natural waters obtained from different parts of the country and at different points in time, many more viruses were usually recovered in BGM cells than in primary rhesus or in African green kidney cells.

The availability of the BGM cell line for research and clinical studies should considerably reduce the need for monkey sacrifice and bring about large cost savings to laboratories requiring such cells.

Dahling, D.R., G. Berg, D. Berman, and R.S. Safferman.

BGM: A New Cell Line for Recovering Viruses from Water.

News of Environmental Research in Cincinnati. U.S. Environmental Protection Agency. September 27, 1974.

Key Words: epidemiology, viruses.

Abstract:

The BGM continuous cell line showed superior viral sensitivity and was far superior to commonly used primary monkey kidney cell cultures in securing effective viral recovery in sewage, sewage effluents, and natural waters. The discovery of this practical application of BGM exemplifies the importance of basic research in bringing about innovations in monitoring technology and enforcement activities.

Dalton, F.E. and R.R. Murphy.

Land Disposal IV. Reclamation and Recycle.

JWPCF. 45(7):1489-1507. July 1973.

Key Words: ponding/land application.

Abstract:

This article provides a general discussion of land disposal with little mention of health effects.

Daniel, J.W.

The Biotransformation of Organomercury Compounds.

Biochemical Journal. 130(2):64-65. November 1972.

Key Words: mercury, ponding/land application, land reclamation.

Abstract:

Organomercury salts have been extensively employed as fungicides in agriculture and in the paper industry, and in human medicine as diuretics. There is ample evidence that organomercuric materials are degraded to inorganic mercury in mammals, soil, and micro-organisms, little is known of the mechanism(s) of this transformation. The author made a literature search of the subject and discusses the efforts and conclusions of the research.

Daniels, S.L. and D.G. Parker.

Removing Phosphorus from Waste Water.

Environmental Science and Technology. 7(8):690-694.
August 1973.

Key Words: phosphates, chemical treatment.

Abstract:

A general discussion on phosphorous in wastewater and its removal by coagulation-flocculation is provided. Many species of aquatic photosynthetic organisms utilize water-soluble anions of phosphorus as nutrient sources. Rampant growths of these organisms produce undesirable tastes and odors in potable waters, contaminate recreational areas, and restrict populations of more desirable organisms such as fish and man. Some legislatures have or are considering bans on the sale of detergents containing phosphorus builders to limit the input of phosphorus to receiving waters. Phosphorus removal must still be practiced in the treatment of municipal waste waters, however, since other sources of phosphorus cannot be controlled at their sources. Significant reductions of all phosphorus species regardless of source are technically feasible in existing waste water treatment plants. These reductions can be accomplished by modifying conventional primary or secondary treatment to include chemical precipitation and flocculation processes. Phosphorus removal by chemical means is currently practiced in the Great Lakes area on a wide scale and is seriously being considered in other areas.

Dappen, G.

Pesticide Analysis from Urban Storm Runoff.

University of Nebraska, Lincoln, August 1974. 44p. (Available from National Technical Information Service (NTIS) as PB-238 593).

Key Words: pesticides, surface water (fresh).

Abstract:

Urban storm runoff was analyzed for pesticide content. Hexachlorobenzene (HCB), pentachloronitrobenzene (PCNB), heptachlor, heptachlor epoxide, lindane, and dacthal were identified and selected for monitoring. Lindane and dacthal were primarily used in the determination of the profile and runoff patterns during a rainstorm. Although pesticide concentrations were higher near the end of the runoff period, the largest amount of pesticide flushing from an area occurred during the maximum runoff period. Major rains, rains that followed periods of wet weather, or rains of longer duration produced higher quantities of pesticides running off than moderate rains of high intensity following dry periods. Much variation in the amount of pesticide running off was encountered.

Davis, E.M. and S.R. Keen.

Municipal Wastewater Bacteria Capable of Surviving Chlorination.

Health Laboratory Science. 11:268-274. October 1974.

Key Words: salmonella, fecal streptococci, coliforms.

Abstract:

This paper discusses the growth of bacteria following chlorination. A comparison is made between chlorinated and unchlorinated wastewater.

Davis, J.A. III and J. Jacknow.

Heavy Metals in Wastewater in Three Urban Areas.

JWPCF. 47(9):2292-2297. September 1975.

Key Words: cadmium, chromium, copper, nickel, zinc, influent characteristics, effluent characteristics.

Abstract:

In order to develop a broader perspective on the impact of heavy metals on water quality, an examination was made of the sources of heavy metals discharged into municipal treatment systems and directly into receiving waters in three urban areas: New York City; Pittsburgh, Pa.; and Muncie, Ind.

The three case studies showed that in areas of high industrial concentration, particularly of industries related to the production of steel or metal fabrication, the industrial sector contributes far more heavy metals to the aquatic environment than does the residential sector. The residential sector contribution may be significant in large cities in which the industrial mix is relatively low in the metals fabrication category, as was shown for New York City.

The residential sector receives some background concentration of heavy metals in its water before it is used and passed on to the collection system. This background concentration may compose a significant portion of the loading from the residential sector and ultimately to the treatment plant. Thus, a comparison of absolute total loadings of the industrial and residential sectors may not be desirable. Perhaps a better comparison of loadings would be based on the water quality depreciation caused by each sector. For example, a comparison of the amount of heavy metals added to water during use by the industrial and residential sectors might be more useful.

Davis, S.

Alternatives for Phosphate Removal.

Water and Sewage Works. 117(10):336-338. October 1970.

Key Words: phosphates, chemical treatment.

Abstract:
The author discusses the removal of $PO_4^{\equiv}$ by lime addition at Lake Tahoe.

Davis, W.K.

Land Disposal III: Land Use Planning.

JWPCF. 45(7):1485-1488. July 1973.

Key Words: ponding/land application.

Abstract:
This article provides a general discussion on land use planning; very little mention of health effects is made.

Day, A.D., J.L. Stroehlein, and T.C. Tucker.

Effects of Treatment Plant Effluent on Soil Properties.

JWPCF. 44(3):373-375. March 1972.

Key Words: nitrates, phosphates, direct contact.

Abstract:

The Ap horizon of soils irrigated with both wastewater effluent and well water for 14 yr had a higher concentration of soluble salts, nitrates, phosphates, calcium plus magnesium, and organic matter than the C horizon. The C horizon of soils irrigated with both wastewater effluent and well water had a higher pH than the Ap horizon.

Soil irrigated with treatment plant effluent had a lower water infiltration rate, higher modulus of rupture, and a higher concentration of soluble salts, nitrates, and phosphates than soil irrigated with well water. The foregoing effects were more evident for some soil properties in either the surface or subsurface soil layers.

Irrigation with wastewater effluent for 14 yr did not decrease field crop yields or result in any adverse effects on Grabe silt loam that could not be corrected with minor changes in field crop culture.

Dean, R.B. and J.E. Smith, Jr.

The Properties of Sludges.

In: Recycling Municipal Sludges and Effluents on Land; Proceedings of the Joint Conference, July 9-13, 1973. pp. 39-47.

Key Words: BOD, nitrates, suspended solids, salmonella,
coliforms, cadmium, copper, nickel, lead, zinc.

Abstract:
The article discusses contaminant properties of sludges.

Dean, R.D.

Disposal and Reuse of Sludge and Sewage - What Are the Options?

Compost Science. 14(5):12-14. September-October 1973.

Key Words: ammonia, nitrates, phosphates, zinc, land reclamation.

Abstract:

This article is a general discussion on the recycling of sludge on land.

Deaner, D.G. and K.D. Kerri.

Regrowth of Fecal Coliforms.

JAWWA. 61(9):465-468. September 1969.

Key Words: coliforms, surface water (fresh).

Abstract:

Analysis of the results of this investigation provide the following conclusions:

1. Tracer studies, if possible, should be utilized to the maximum extent in any bacteriological field sampling program, to reveal the most suitable locations for obtaining representative samples.

2. No increase in numbers (regrowth) was found to occur in fecal coliform organisms below the outfall of a highly treated wastewater during the sampling period of this investigation.

3. Significant inhibitory factors which may have accounted for this lack of growth were the short travel time of organisms within the study section, a lack of bacterial nutrients available to the organisms, and physiographic features of the river which included shallowness, swiftness, and low turbidities.

Dean-Raymond, D. and R. Bartha.

Biodegradation of Some Polynuclear Aromatic Petroleum Components by Marine Bacteria.

Rutgers-the State University, New Brunswick, February 1975.
21p. (Available from National Technical Information Service (NTIS) as AD/A-006 346).

Key Words: synthetic/organics, surface water (marine).

Abstract:

The metabolism of polynuclear aromatic hydrocarbons was studied using gas chromatographic, thin-layer chromatographic, infrared and mass spectrometric techniques. Of six bacterial strains isolated from oil polluted estuarine water, all grew on naphthalene, 2-methylnaphthalene and 2-ethylnaphthalene as sole sources of carbon and energy. Several other alkyl naphthalenes were metabolized by various strains. Phenanthrene and anthracene were metabolized by three out of six organisms. Only one naphthalene-grown strain was able to metabolize other polyaromatic compounds, including acenaphthylene, biphenyl, fluorene and tetralin. The specificity of salicylate hydroxylase governs the utilization of several naphthalene derivatives while inability to oxidize naphthoic acids prevents growth on dimethynaphthalenes.

DeBoise, J.N. and J.F. Thomas.

Chemical Treatment for Phosphate Control.

JWPCF. 47(9):2246-2255. September 1975.

Key Words: phosphates, chlorides, chemical treatment, effluent characteristics.

Abstract:

The objectives of this study were (1) to develop a rational, comprehensive model of calcium phosphate precipitation capable of evaluating chemical treatment over the range of conditions occurring in wastewater treatment systems; (2) to develop a computer model, based on that mathematical model, of calcium phosphate precipitation as it occurs in wastewater treatment processes. This model would have the capabilities of predicting the residual phosphate from any given system, of determining the chemical dosage required to minimize residual phosphate in any given system, and of determining the effects of changes in any of the pertinent ions of the system on the results of the process; and (3) to determine, by use of the computer model, the general effects of variations in the components of the precipitation system and the results to be expected from application of chemical treatment to various wastes.

DeFlora, S, G.P. DeRenzi and G. Badolati.

Detection of Animal Viruses in Coastal Seawater and Sediments.

Applied Microbiology. 30(3):472-475.

Key Words: viruses, surface water (marine), epidemiology.

Abstract:

Animal viruses, predominantly enteroviruses, were detected in shallow waters at bottom depths and in clastic marine sediments. Viruses accumulated in sandy and slimy deposits of the sea bottom near the shore and could be easily released into water by means of simple mechanical shaking.

de Goeij, J.J.M., V.P. Guinn, D.R. Young, and A.J. Mearns.

Neutron Activation Analysis Trace-Element Studies of Dover Sole Liver and Marine Sediments.

In: Comparative Studies of Food and Environmental Contamination. International Atomic Energy Agency, Vienna, 1974. pp. 189-200.

Key Words: arsenic, antimony, cadmium, cobalt, copper, mercury, molybdenum, zinc, surface water (fresh), surface water (marine), fish.

Abstract:

This study has been aimed at determining the present levels of trace elements in the liver of Dover sole, collected from polluted as well as unpolluted areas around and down-current of the major Los Angeles area sewage outfalls in the Pacific Ocean. A radiochemical-separation scheme was devised for the analysis of Dover sole liver and some sediment samples. The post-irradiation chemistry includes a destruction with sulphuric acid and hydrogen peroxide, a distillation with hydrobromic acid, and an absorption of quite a few elements of the distillate and residue, each on a Dowex anion exchanger. In the residue resin the elements molybdenum, cadmium, copper, zinc, iron and cobalt, and in the distillate resin the elements mercury, selenium, arsenic, and antimony were simultaneously measured using a Ge(Li) detector. The ranges of concentrations found in Dover sole liver (wet-weight basis) are: 0.050 - 0.39 ppm Hg, 0.23 - 1.9 ppm Se, 0.001 - 0.007 ppm Sb, 0.70 - 4.3 ppm As, 0.040 - 0.20 ppm Mo, 0.060 - 6.9 ppm Cd, 1.1 - 9.2 ppm Cu, 19-39 ppm Zn, 105-319 ppm Fe, 0.017 - 0.10 ppm Co. Surprisingly, no significant differences have been observed in these element levels between sole caught in polluted and unpolluted areas, even though sole is a "bottom-feeder" type of fish and the ocean sediments in the polluted areas sometimes contain concentrations of these elements 10 to 150 times higher than in the unpolluted areas. The method has also been applied to the analysis of a sediment core taken near an outfall. The results show a strong decrease of the levels of mercury, arsenic, selenium, and antimony with increasing depth of the sediment layers.

Degradation of Synthetic Organic Molecules in the Biosphere:
Natural, Pesticidal, and Various Other Man-Made Compounds.

National Academy of Sciences, Washington, D.C. 1972. 350p.

Key Words: synthetic/organics, bacteria, chlorinated hydrocarbons, pesticides, surface water (fresh), surface water (marine).

Abstract:

The proceedings of a conference concerning degradation of synthetic organic molecules by the lower phyta are presented.

Dehlinger, P.; _et al_.

Investigations on Concentrations, Distributions, and Fates of Heavy Metal Wastes in Parts of Long Island Sound.

University of Connecticut, Groton, Marine Sciences Institute, October 1974. 127p. (Available from National Technical Information Service (NTIS) as COM-75-110119).

Key Words: copper, mercury, zinc, surface water (marine),

Abstract:

A two-year investigation was conducted on heavy metal wastes in Long Island Sound, with emphasis on the eastern Sound and the Connecticut coast. The program consisted of five integrated projects with the ultimate objective being to determine a preliminary budget of these wastes. The projects were concerned with the concentrations, distributions, and fates of heavy metals in the water column, water circulation patterns and water renewal times in the Sound, the structure and outflow of the Connecticut River into the Sound, the transport of suspended materials in the Sound, and the uptake of metals in oysters at various locations along the Connecticut coast.

Delfino, J.J., G.C. Bortleson, and G.F. Lee.

Distribution of Mn, Fe, Mg, K, Na, and Ca in the Surface Sediments of Lake Mendota, Wisconsin.

Environmental Science and Technology. 3:1189-1192. November 1969.

Key Words: iron, manganese, surface water (fresh).

Abstract:

Analysis of 32 surface sediment samples from different areas of Lake Mendota, Wis., indicated a high positive statistical correlation between Mn, Fe, and P concentration in the sample and the depth of water overlying the point of sample recovery. An inverse correlation was found for Mg and K. No statistical correlation between concentration and depth of sample recovery was found for Ca and Na.

DeMichele, E.

Pathogenic Organisms in the Murderkill River Estuary.

JWPCF. 46(4):772-776. April 1974.

Key Words: salmonella, fecal streptococci, coliforms, surface water (fresh), influent characteristics.

Abstract:

1. The FC concentrations ranged from 20 to 16,000/100 ml, with 45 percent of the samples having concentrations greater than 200/100 ml.

2. The FS concentration range was 10 to 11,300/100 ml, with 90 percent of all samples having concentrations greater than 200/100 ml.

3. Applying Geldreich's summary on the probability of pathogenic organism isolation (salmonella), a 90-percent FS count greater than 200/100 ml may indicate an 85-percent frequency of isolation of salmonella in the Murderkill River.

4. The FC:FS ratio always was less than 4.0, with almost 90 percent of all ratios less than 0.7. This may indicate that animal wastes are the principal sources of pollution in this estuary.

5. The FC and FS concentrations decreased logarithmically from station 4 to the river mouth. Although domestic and industrial wastewater sources are absent from the downstream river sections, the marshy areas cause an increase in indicator counts between the mouth of the river (Station 00) and Station 4.

Demichele, E.

Water Reuse, Virus Removal and Public Health.

In: Virus Survival in Water and Wastewater Systems.
J.F. Malina, Jr., and B.P. Sagik, eds. University of Texas
at Austin, Center for Research in Water Resources, 1974.
pp. 45-56.

Key Words: epidemiology, viruses.

Abstract:

Reused treated water represents an increasing fraction of this nation's total water resources.

The number of waterborne disease outbreaks has not declined since 1955. From 1946 to 1970, more than 358 outbreaks affected more than 72,000 people.

Enteric viruses can be transmitted by the water route; standard analyses for bacteria cannot satisfactorily predict the presence of viruses.

Lack of adequate virus detection methods and inefficient disinfection processes mean that the degree of assurance needed for potable reuse of treated waters presently does not exist.

DeMichele, E., G.W. Burke, Jr. and M.S. Shane.

The Need for an Indicator Virus in Water Quality Testing.

Water and Sewage Works. 121(4). April 1974.

Key Words: viruses, epidemiology.

Abstract:

The argument is made that an adequate biological indicator for viruses in various waters is not now available and should be sought.

Deneke, C.F. and R.R. Colwell.

Lipopolysaccharide and Proteins of the Cell Envelope of *Vibrio marinus*, a marine bacterium.

Canadian Journal of Microbiology. 19(10):1211-1217. 1973.

Key Words: bacteria, surface water (marine).

Abstract:
Lipopolysaccharides isolated from the marine bacterium *Vibrio marinus* strain PS-207 were found to be similar to the lipopolysaccharides of R mutants of enteric organisms, with respect to extraction characteristics, percentage of lipid A (61%), and sugars of the polysaccharide side chain (glucose and heptose). A high ratio (2:1) of phosphate to amino sugar was found in the lipid A. Hydroxy fatty acids constituted only 14% of the total fatty acids of the lipid A fraction, whereas branched and straight-chain fatty acids were present in greater abundance. The major envelope proteins of *V. marinus* strain PS-207 fell into three molecular weight classes determined by SDS gel electrophoresis. Numerous protein species were observed in urea-acetic polyacrylamide gel electrophoresis preparations.

Deneke, C.F. and R.R. Colwell.

Studies of the Cell Envelope of Vibrio parahaemolyticus.

Journal of Microbiology. 19(2):241-245. 1973.

Key Words: bacteria, viruses, surface water (marine).

Abstract:
Components of the cell envelope of Vibrio parahaemolyticus were investigated. Vibrio parahaemolyticus is an estuarine microorganism associated with diseases of marine and estuarine animals and seafood-borne enteritis in man. Purified lipopolysaccharide (LPS), isolated using a 45% phenol extraction procedure, was found to contain lipid A fraction to 27% of the LPS by weight. In the lipid A fraction, glucosamine was the only amino sugar to be present and a high molar ratio of phosphate to amino sugar (2.5:1) was noted. Two hydroxy fatty acids, hydroxydodecanoic and hydroxymyristic, were identified among the fatty acids by gas-liquid chromatography. A role of the lipopolysaccharides in the salt requirement of marine bacteria is suggested.

Denis, F.A., E. Blanchoun, A. DeLignieres, and P. Flamen.

Coxsackie A_{16} Infection from Lake Water.

Journal of the American Medical Association. 228(11):1370-1371. 1974.

Key Words: coxsackie virus, epidemiology, surface water (fresh).

Abstract:
Coxsackie virus A_{16} was recovered from the rectal swabs of two boys with gastrointestinal disease and from lake water in which they had bathed a few days before onset of illness.

Dennis, J.M.

1955-1956 Infectious Hepatitis Epidemic in Delhi, India.

JAWWA. 51:1288-1296. October 1959.

Key Words: hepatitis virus, surface water (fresh), drinking and recreational water.

Abstract:

This article reports on the cause and actual extent of the infectious hepatitis epidemic in Delhi, India in 1955. This was the first well-documented epidemic of infectious hepatitis involving a treated water supply. The author concludes that it was probable that receding floods in the Jumna River permitted heavy contamination at the water treatment plants which did not have adequate chlorination capacity.

de Vries, J.

Soil Filtration of Wastewater Effluent and the Mechanism of Pore Clogging.

JWPCF. 44(4):565-573. April 1972.

Key Words: BOD, phosphates, filtration.

Abstract:

The physical condition of sand filters did not deteriorate as a result of daily applications of effluent from a primary wastewater treatment plant for 240 days at a rate of 20 cm/day, 5 days/wk, with a daily application period of 2 hr. The filters were drained during the rest periods to maintain aerobic conditions. Periodic O_2 and CO_2 measurements after an effluent application showed that the rest period between applications should be at least 22 hr.

Effluent applications at the same rate, but at a temperature of $4^o \pm 3^oC$, allowing the same daily rest periods, resulted in failure in 10 days because of pore clogging. In situ pore size distribution and saturated hydraulic conductivity measurements showed that the clogged pores were on the soil surface, scaling off the surface pores. The existence of a surface deposit of sludge was confirmed visually.

Periodic O_2 and CO_2 measurements showed that at room temperature, the failed filters recovered in about 8 days. The hydraulic conductivity and relative soil volume occupied by large pores in the surface layer of the recovered filters was higher than that of the original sand fractions, indicating disruption of the sludge layer during the recovery period. It was speculated that structural improvement of the dark surface layer is related to accumulated organic matter.

Renovation of wastewater effluent with respect to BOD and phosphate was close to 100 percent as a result of treatment with the fine sand filter. The favorable renovation with respect to phosphate was caused by the coatings of Fe_2O_3 and Al_2O_3 on sand grains. Treatment with the medium Ottawa sand at the sand loading rate resulted in only partial renovation with respect to BOD and phosphate. Treatment with both sand fractions resulted in a renovation of about 25 percent with respect to nitrate.

DeWalle, F.B. and E.S.K. Chian.

Removal of Organic Matter by Activated Carbon Columns.

Journal of the Environmental Engineering Division, ASCE.
100(EE5):1089-1104. October 1974.

Key Words: BOD, total organic carbon.

Abstract:

This study shows that the major organic fraction adsorbed in activated carbon columns is a fulvic acid-like material with a molecular weight ranging from approximately 100-10,000. Both the low molecular weight fraction consisting of mostly polar organic compounds and the high molecular weight humic carbohydrate-like material, with a molecular weight above 50,000, are poorly adsorbed in carbon columns. Previous studies by the writers on the aerobic degradation of a naturally occurring wastewater by activated sludge showed a decrease of the material smaller than 100 MW and an increase in the fulvic and humic-like material during the course of the biological degradation. Since the fulvic acid-like compounds adsorb very well in activated carbon columns, and since they represent a major fraction of the organic matter, adsorption in activated carbon columns is expected to increase with increasing degradation of the wastewater. Such a result was indeed found in a later study in which the TOC removal of the filtered mixed liquor by activated carbon increased in the succeeding compartments of a plug-flow activated sludge unit.

Dewling, R.T., I. Seidenberg, and J. Kingery.

Effect of Seasonal Effluent Chlorination on Coliforms in Jamaica Bay.

JWPCF. 42(7):1351-1362. July 1970.

Key Words: coliforms, surface water (marine).

Abstract:

Analysis of the bacteriological data collected in Jamaica Bay during this 8-month long effluent chlorination study, which involved six secondary treatment plants discharging more than 160 mgd (606,000 cu m/day), has shown that:

1. There was a significant decrease in the coliform populations present in most parts of the Bay following the start-up of post-chlorination of effluents at the treatment plants.

2. There was a significant increase in coliform populations at most Bay stations following the cessation of post-chlorination.

3. The estimated response time of most of the Bay stations to this change in treatment at the plants - start-up and cessation of chlorination - ranged from 24 to 48 hr.

4. The effect of the discharge of storm and combined sewer overflows can be detected in most of the Bay for 2 to 3 days following a storm.

5. Post-chlorination of wastewater treatment plant effluents, even when the daily volume of these discharges represents less than 0.5 percent of the volume of the receiving water,is an effective means for improving the bacteriological quality of the receiving water.

Dewling, R.T., R.D. Spear, P.W. Anderson, and R.J. Braun.

EPA's Position on Ocean Disposal in the New York Bight.

In: Pretreatment and Ultimate Disposal of Wastewater Solids. A. Freiberger, ed. EPA-902/9-74-002, Environmental Protection Agency, Region II, New York, 1974. pp. 283-330.

Key Words: coliforms, surface water (marine).

Abstract:

Based upon sampling in the surf and near shore waters along the Long Island and New Jersey beaches, it is evident that water quality remains excellent with respect to coliform density and is acceptable for contact recreation. More important, there is no evidence of a trend towards increased coliform density and thus, no indication of degradation. The occasional elevated coliform counts noted appear randomly distributed in time and location, and does not indicate a systematic change or degradation of water quality.

Review of data from sampling in the Bight of the water column and bottom sediments indicate the general location of the sludge mass associated with the sewage sludge and dredge spoil dump site. A "clean water-sediment" zone of about 5½ to 6 miles separates at the leading edge of the sludge mass from the New Jersey and Long Island coasts. Slightly elevated organic carbon content and bacterial counts at selected near shore sampling stations can be related to inland occurrences, such as runoff and wastewater discharges.

Dexter, R.N. and S.P. Pavlou.

Characterization of Polychlorinated Biphenyl Distribution in the Marine Environment.

University of Washington, Seattle.

Key Words: synthetic /organics, surface water (marine).

Abstract:
The paper describes a spectral analysis technique which can be used to describe chlorobiphenyl phases and distributions in the ocean.

Dexter, R.N. and S.P. Pavlou.

Chemical Inhibition of Phytoplankton Growth Dynamics by Synthetic-Organic Compounds.

Journées d'Etudes Pollutions, Athens, C.I.E.S.M., 1972. pp.155-157.

Key Words: synthetic /organics, surface water (fresh), surface water (marine), fish, shellfish.

Abstract:

Batch and continuous culture techniques were used in the lab to study inhibition of phytoplankton growth by synthetic organic compounds, especially PCB's. Although such predictions are not made in the article, the results should make it possible to predict the impacts of these pollutants on the primary productivity of a near shore environment.

Diaper, E.W.J.

Practical Aspects of Water and Waste Water Treatment by Ozone.

In: Ozone in Water and Wastewater Treatment. F.L. Evans, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1972. pp. 145-179.

Key Words: BOD, COD, synthetic/organics, viruses, bacteria, ozonation.

Abstract:

Ozone cannot be bottled and must be generated on site, which avoids the hazard present in carrying chlorine containers through municipal areas. In comparative tests with chlorine, ozone has been found more effective in killing bacteria and viruses and in removing organic color, taste, and odor. Its action is virtually instantaneous, requiring no large contact tanks.

In the treatment of industrial effluents, ozone is used to reduce BOD and COD and to destroy objectionable chemical compounds such as phenols and cyanides.

The combination of Microstraining and Ozonation (Microzon) has been tested on municipal sewage effluents in London and Chicago. Microstraining will remove the majority of suspended solids contained in the secondary effluent, and ozone will kill the vast majority of organisms present, including all bacteria and viruses. A noticeable effect of ozone is to remove the color of the effluent. Other beneficial effects include high dissolved oxygen and removal of detergent residues.

When applying relatively large doses of ozone, special systems must be used for contacting the water. Normally, ozone is applied in parallel to several stages through which the water flows in series. By this means, the water receives successive increments of ozone which is applied as soon as possible after generation to prevent any reduction in its oxidizing power. A multicontactor system of this type is at present under investigation on sewage effluents in the Blue Plains Plant in Washington, D.C.

In Philadelphia, a Microzon system is being tested on storm water overflows from combined sewers.

Modern ozone generators employ electrode systems made up of a series of tubes or plates equipped with insulators and provided with cooling arrangements. Specially designed transformers step up the normal mains voltage

to 15,000 or 20,000 volts. Air preparation equipment comprises filters and driers using refrigeration and desiccation. The design of these units has been well established over many years, and they incorporate high quality materials completely protected by fail-safe devices. Ozone costs approximately 8 cents per pound when made from oxygen. Installation costs range from $500 to $1,000 for each pound per day of ozone generating capacity.

An outstanding advantage of ozone is its immediate and effective attack on viruses in water supplies. Medical evidence shows that dilutions of polio virus can be rendered inactive in 2 minutes by a small dosage of ozone, whereas chlorine may take several hours and much higher doses. This aspect of ozone will undoubtedly bring it into more common use in this country as the search continues for higher quality water supplies.

Diaper, E.W.J. and G.E. Glover.

Microstraining of Combined Sewer Overflows.

JWPCF. 43(10):2101-2113. October 1971.

Key Words: coliforms, bacteria, ammonia, BOD, COD, suspended solids, microstraining, chlorination, ozonation, influent characteristics, effluent characteristics.

Abstract:

Treatment of an actual overflow by microstraining in a residential area of Philadelphia has produced solids removal up to 98 percent. Limited data for a fine Mark 0 (23-μ) screen under relatively high throughput conditions show removal figures ranging from 78 to 98 percent, with an average of 91 percent. Figures for a larger number of tests made with lower throughputs show a solids removal range of 62 to 96 percent, with an average of 80 percent.

VSS removals have roughly paralleled the experience with TSS. These removals for the Mark I (35-μ) screen averaged 47 percent and for the three modes of operation using the Mark 0 screen have averaged 68, 71, and 71 percent.

Bacteriological results measured across the microstrainer screen exhibit anomalies, both reductions and increases in total and fecal coliform being measured. Further major total coliform reductions can, of course, be achieved with chlorine or ozone. The results presented herein with both ozone and chlorine, although again anomolous in some instances, indicate a slightly better performance with chlorine at the concentrations used. In some work, carried out near the end of the program, 15 mg/l of chlorine with only 2 min of detention produced greater bacteriological kills than a lower concentration with longer detention.

BOD removals across the microstrainer have been difficult to measure. In those cases where reductions have been recorded, the average reduction has been 65 percent across the Mark 0 screen. However, in 8 of the 17 measurements, increases in BOD are shown across the microstrainer.

Hypotheses have been made for the observed increase in BOD and bacteriological results.

The special conditions of stormwater overflow make it vastly different from other municipal wastewaters and require a different treatment approach.

Perhaps foremost of these special conditions are the high instantaneous flow rates and the fact that the treatment facility must operate for only relatively short time periods after relatively long idle periods.

DiGirolamo, R., L. Wiczynski, M. Daley, and F. Miranda.

Preliminary Observations on the Uptake of Poliovirus by West Coast Shore Crabs.

Applied Microbiology. 23:170-171. January 1972.

Key Words: polio virus, shellfish.

Abstract:
Crabs will uptake poliovirus when consuming contaminated mussels. Data are provided.

DiGirolamo, R., J. Liston, and J.R. Matches.

Survival of Virus in Chilled, Frozen, and Processed Oysters.

Applied Microbiology. 20:58-63. July 1970.

Key Words: polio virus, shellfish.

Abstract:

Samples of whole and shucked Pacific and Olympia oysters, contaminated with 10^4-plaque-forming units (PFU) of poliovirus Lsc-2ab per ml, were held refrigerated at two temperatures, 5 and -17.5 C. To study the survival of virus in the oysters under these conditions, samples were assayed for virus content at weekly intervals for as long as 12 weeks. Results indicated that poliovirus would survive in refrigerated oysters for a period varying from 30 to 90 days, depending upon temperature. The survival rate varied from 10 to 13%. To study the extent of the hazard presented by oysters contaminated with virus, samples of whole and shucked Pacific oysters contaminated with 10^4PFU of poliovirus Lsc-2ab per ml were heat processed in four ways: by stewing, frying, baking, and steaming. Results indicated that virus in oysters withstood these methods of processing. The survival rate varied from 7 to 10% and appeared dependent upon the processing method used. Heat penetration studies showed that the internal temperature in the oyster was not sufficient to inactivate all of the virus present. These results suggest that not only fresh but also refrigerated and cooked oysters can serve as vectors for the dissemination of virus disease if the shellfish are harvested from a polluted area.

Dilling, W.L., N.B. Tefertiller, and G.J. Kallos.

Evaporation Rates and Reactivities of Methylene Chloride, Chloroform, 1,1,1-Trichlorolthane, Trichlorolthylene, Tetrachlorolthylene, and Other Chlorinated Compounds in Dilute Aqueous Solutions.

Environmental Science and Technology. 9(9):833-838. September 1975.

Key Words: chlorinated hydrocarbons, surface water (fresh), surface water (marine).

Abstract:

To estimate the persistence of low-molecular-weight chlorinated hydrocarbons in natural water bodies, we carried out laboratory studies on the evaporation and reaction rates of the title compounds at the 1-ppm level in water under ambient conditions. All five compounds had evaporated to the extent of 50% in less than 30 min and to 90% in less than 90 min when stirred (200 rpm) in water at ~25°C in an open container. Addition of various contaminants (clay, limestone, sand, salt, peat moss, and kerosine) to the water had relatively little effect on the chlorinated compounds' evaporation or disappearance rates. The hydrolytic-oxidative reaction half-lives for the title compounds in sealed ampules were ~6-18 months. These data indicate that 1-ppm concentrations of low-molecular-weight chlorinated hydrocarbons would not persist in agitated natural water bodies due to evaporation.

Dimond, J.B., A.S. Getchell, and J.A. Blease.

Accumulation and Persistence of DDT in a Lotic Ecosystem.

Journal of the Fisheries Research Board of Canada.
28(12):1877-1882. December 1971.

Key Words: DDT, surface water (fresh), fish.

Abstract:

DDT persisted in streams of several small watersheds in Maine for at least 10 years following light applications to the forest. Residues declined sharply within 2 or 3 years after application but after 10 years were still well above concentrations detected in untreated streams. This was true of all components studied: muds, plants, invertebrates, fish, and fish-eating birds. The prolonged persistence led to cumulative residue levels in streams sprayed more than once. Concentration of residues through the food chain was evident.

Directo, L.S. and C. Chen.

Pilot Plant Study of Physical-Chemical Treatment.

Presented at the 47th Annual Water Pollution Control Federation Conference, Denver, Colorado, October 1974.

Key Words: BOD, phosphates, nitrates, suspended solids, adsorption/ion exchange, ponding/land application.

Abstract:
Reduction effects of physical-chemical treatment are discussed.

Directo, L.S., C. Chen, and R.P. Miele.

Aerobic Stabilization by Denitrification Study.

EPA Contract No. 14-12-150, Los Angeles County Sanitation Districts, Los Angeles, California. 48p.

Key Words: ammonia, nitrates, aerobic digestion.

Abstract:

A pilot-scale aerobic stabilization-denitrification study, using six 55-gallon biological reactors, was conducted under batch operating conditions for a period of about 4 months. During that period, various types of sludges, such as waste activated sludge, raw sludge and sludge mixtures, were aerobically stabilized and subsequently denitrified. The objectives of the study were to evaluate the feasibility of reducing the nitrogen level in the various types of sludges by biological nitrification and denitrification and to determine the effect of the nitrification-denitrification process on the dewatering and filtration properties of the sludges.

Operating data collected during the study has demonstrated that the nitrogen content of the various types of sludges could be reduced by the combined process of biological nitrification-denitrification. The preliminary data, however, indicate that the process is not a practical choice as far as raw sewage is concerned because of the excessively long detention times required and the presence of the unavoidable odor problems.

In the course of the nitrification-denitrification process, significant amounts of mixed liquor COD and volatile solids were removed, in addition to that of nitrogen.

The effect of aerobic stabilization and subsequent anaerobic treatment phase on sludge filterability and drainability varied with the type of sludge. In addition, the rate of aeration had an effect on sludge filterability and drainability.

Directo, L.S., R.P. Miele, and A.N. Masse.

Phosphate Removal by Mineral Addition to Secondary and Tertiary Treatment Systems.

Presented at the 27th Industrial Waste Conference, Purdue University, May 1972.

Key Words: phosphates, activated sludge, chemical treatment.

Abstract:

This study has demonstrated that it is possible to obtain a high level of phosphate removal from wastewater by the addition of either ferric chloride or alum to the aeration system of an activated sludge plant. However, to achieve good quality effluent in the combined chemical-biological system, a supplemental polishing treatment would be required. The effectiveness of sand filtration as a polishing step was demonstrated during the course of the study.

The biological performance of the activated sludge plant as measured by the COD removal efficiency was not adversely affected by Al:P molar ratios as high as 1.9:1 and Fe:P molar ratios up to 2.2:1. However, at a Fe:P molar ratio of 3:1 a definite disruption of the activated sludge system was observed. The weight of the sludge produced in the combined chemical-biological system was approximately twice that of the biological process alone. However, the volume of excess activated sludge wasted did not increase during chemical addition periods.

The study also demonstrated that phosphate removal could be accomplished in a combined secondary-tertiary system, in which the ferric chloride dosage was divided between the two systems, and by ferric chloride addition to a tertiary system alone. The study demonstrated that the most efficient utilization of chemicals was obtained from the combined secondary-tertiary treatment system.

Directo, L.S., C. Chen, and R.P. Miele.

Physical Chemical Treatment of Raw Sewage.

EPA Contract No. 14-12-150, Los Angeles County Sanitation Districts, Los Angeles, California. 104p.

Key Words: COD, chemical treatment, adsorption/ion exchange.

Abstract:

A 3.17 l/sec (50gpm) pilot plant evaluation of the physical-chemical treatment (PCT) process was conducted for 27 months at Pomona, California; the pilot plant consisted of chemical clarification with alum at 25 mg/l as Al and an anionic polynier at 0.3 mg/l, followed by a single-stage, pressurized downflow carbon column operated at a hydraulic loading of 2.71 l/sec/cm^2 (4 gpm/ft^2) and an empty-bed contact time of 30 minutes. The main objectives of the study were to evaluate various methods of controlling sulfide generation in the carbon column and to determine the effects of repeated thermal regeneration cycles on the adsorption capacity, carbon loss and pressure drop buildup of PCT carbon.

Performance data obtained demonstrated the stability of the PCT system in producing affluent of excellent overall quality. The suspended solids, total COD and total phosphate removals in the PCT system were 96.6%, 94% and 92%, respectively.

In the course of the study, several methods of controlling sulfide generation in the carbon column, such as oxygenation, chlorination and sodium nitrate addition, were evaluated; continuous sodium nitrate addition to the carbon column at an average dosage of 5.4 mg/l N was found most effective in preventing sulfide generation.

The addition of nitrate had another favorable effect in that it permitted, through enhancement of biological activity, a very high organic loading on the carbon column. At the end of the first cycle, the carbon capacity was 3.54 lbs. total COD removed/lb carbon and 1.54 lbs. dissolved COD removed/lb carbon.

Although regeneration was not necessary, it was conducted in an effort to obtain data on the effects of repeated regenerations on the carbon characteristics. These were the first large-scale regenerations of granular activated carbon used in the PCT mode. In all respects, the regenerated carbon was found equal to or slightly better than that of the virgin carbon.

Directo, L.S., C. Chen, and R.P. Miele.

Two-Stage Granular Activated Carbon Treatment.

Los Angeles County Sanitation Districts for Advanced Waste Treatment Research Center.

Key Words: COD, suspended solids, adsorption/ion exchange.

Abstract:

Two 6.3 l/sec (0.15 mgd), two-stage, packed-bed, downflow granular activated carbon pilot plants were operated continuously for 33 months using unfiltered and unchlorinated activated sludge plant effluent. The main objective of the study was to evaluate the effect of repeated thermal regeneration cycles on the adsorption capacity, regeneration loss and pressure drop buildup of carbon with different particle size. Performance data, collected during the field study, has demonstrated the stability of the two-stage carbon adsorptive system in consistently producing effluents of excellent overall quality.

Disinfection of Wastewater, Task Force Report.

Environmental Protection Agency, Washington D.C., Municipal Construction Division, July 1975. 67p. (Available from National Technical Information Service (NTIS) as PB-257 449).

Key Words: viruses, chlorination, ozonation, radiation treatment.

Abstract:
The Task Force believes that the disinfection of wastewater for pathogen destruction is of obvious public health importance since these organisms, if not destroyed, could be transmitted to man through sewage contamination of water for drinking, food processing, irrigation, shellfish culture or recreational purposes. However, the application of disinfection regulations should be periodically updated to take advantage of new findings and technology in order that EPA make prudent and efficient use of our nation's resources in administering the secondary treatment regulations. There are a number of conclusions that can be made from this Task Force report that would help to support new policy decisions on disinfection.

Dismukes, W.E., A.L. Bisno, S. Katz, and R.F. Johnson.

An Outbreak of Gastroentiritis and Infectious Hepatitis Attributed to Raw Clams.

American Journal of Epidemiology. 89(5):555-561. May 1969.

Key Words: epidemiology, hepatitis virus, shellfish.

Abstract:

An outbreak of 33 cases of gastroenteric illnesses of unproven etiology and four cases of infectious hepatitis occurred among 128 persons who attended a picnic in August 1966. In general, the gastroenteric illnesses developed 24 to 48 hours after the picnic, lasted one to three days, and were characterized by diarrhea, nausea, vomiting, and abdominal cramps. The illnesses were related by food histories to ingestion of raw clams (*Mercenaria mercenaria*) at the picnic. The four picnickers who developed hepatitis 22, 26, 37, and 40 days after the picnic had all eaten raw clams, and three had experienced the gastroenteric illness. Contamination of the clams probably occurred in the waters from which the clams were harvested. This outbreak of shellfish-associated gastroenteritis and hepatitis provides additional evidence that clams serve as a potential vehicle for the transmission of those diseases.

Disposal of Sewage Sludge into a Sanitary Landfill.

EPA/SW-71d, Ralph Stone and Company for City of Oceanside, California, 1974. 462p. (Available from National Technical Information Service (NTIS) as PB-258 680).

Key Words: BOD, virus, bacteria, land reclamation.

Abstract:

This report describes the results of a three-year demonstration study of the disposal of liquid sewage sludge and septic tank pumpings into solid waste at a sanitary landfill. Bench-scale laboratory studies were conducted to determine the moisture-absorbing capacity of typical solid waste constituents and to establish characteristics of admixture with various sludges. The composition and quantity of solid waste produced in the City of Oceanside were determined by quarterly waste samplings and waste collection vehicle weighings.

Pilot plant lysimeters were employed to investigate the effects of sewage and septic tank sludges on solid waste temperature, decomposition, leachate, settlement, insects, odor and gas characteristics. Three large field lysimeters were built at the City of Oceanside, California municipal landfill, each holding one week's production of all municipal solid waste and sewage sludge. The field test cells were lined with a 10-mil polyethylene membrane to collect the leachate for measuring and sampling. Full-scale demonstration landfill operations studies were conducted at the City landfills -- initially with limited sludge disposal one day per week, and with 100 percent sludge disposal later in the study.

The large field lysimeters were monitored for leachate, temperature, gas, compaction, settlement and waste decomposition (as determined by core sampling). The full-scale landfill disposal of sludge was monitored for runoff, leachate, equipment operating efficiency (time and motion studies), odor, vector problems, blowing litter, and weather conditions (rainfall, temperature, wind and evaporation).

Results of the study indicated that Oceanside solid waste has sufficient ability to absorb moisture without producing runoff. Full-scale sludge disposal at the Oceanside landfill produced no leachate and was economically feasible. Benefits of full-scale disposal included increased landfill compaction, greater density, and reduced blowing of litter and dust; problems included odors following raw sludge or septic tank pumpings disposal (not recommended unless special protection measures are provided), and bird foraging.

The report describes the sanitary landfill operating and design factors for disposing digested sludge and its effects on the sanitary landfill and environment.

Disposal of Wastes from Water Treatment Plants - Part I.

JAWWA. 61(10):541-566. October 1967.

Key Words: BOD, COD, suspended solids, aluminum, iron, manganese, chemical treatment, effluent characteristics.

Abstract:

Perhaps the most important parameter in discussing wastewater sludge is the solids content. Reported values for alum sludges range from 1,000 to 17,000 mg/l dry solids, with suspended solids usually accounting for 75 to 90 percent of the total. The volatile content ranges from 20 to 35 percent of total solids.

The biochemical oxygen demand (BOD) is relatively low, approximately that of secondary sewage effluent. In carrying the BOD test to its ultimate value, it was found that a considerable amount of BOD was exerted after the initial 5-day period. In one instance, the 5-day BOD was less than 30 percent of the ultimate demand. Typical values of 5-day BOD range from 30 to approximately 150 mg/l.

The chemical oxygen demand (COD) is considerably higher. It has been found to range anywhere from 500 to 15,000 mg/l, the higher value being due to activated carbon present in the sample.

Dixon, J.K. and M.W. Zielyk.

Control of the Bacterial Content of Water with Synthetic Polymeric Flocculants.

Environmental Science and Technology. 3:551-558. June 1969.

Key Words: bacteria, chemical treatment.

Abstract:

In a study of synthetic polymers for flocculation of bacteria in water, filtration rates, electrophoretic mobility, and light transmission were measured to evaluate flocculation. *E. coli* were studied at bacterial concentrations of 50 to 2700 mg. per liter and at pH 4 to 9 with nonionic, anionic, and cationic polymers as flocculants. Nonionic and anionic polyacrylamides were studied with molecular weights from 7000 to 3,000,000, without evidence of flocculation at polymer concentrations of 0.1 to 50 mg. per liter. Cationic polyethyleneimines with molecular weights from 300 to 112,000 were effective at concentrations from 0.1 to 80 mg. per liter, but molecular weight had no effect on the amount of polymer required to initiate flocculation. Low molecular weight polymers at concentrations even in excess of 800 mg. per liter caused flocculation, but above about 10 mg. per liter the high molecular weight polymers caused redispersal of the bacteria. The results for the polymer-bacteria systems are similar to those obtained for flocculation of some inorganic and bio-colloid systems. The cationic polyethyleneimines should be of practical value for quality control of water because of their ability to flocculate and settle solids of various types at low dosage levels.

Dixon, K.R. and J.A. Kadlec.

A Model for Predicting the Effects of Sewage Effluent on Wetland Ecosystems.

University of Michigan, Wetlands Ecosystem Research Group
Ann Arbor, February 1975. 66p.

Key Word: surface water (fresh).

Abstract:

A mathematical model of the organic matter components of a wetland ecosystem was developed, primarily from data in the published literature. The biomass models developed will be combined with models for nutrients and water to make actual forecasts of the effects of sewage wastewater disposal on the marsh ecosystem.

Doherty, R.A. and A.H. Gates.

Epidemic Human Methylmercury Poisoning - Application of a Mouse Model System.

Pediatric Research. 7(4):319-391. 1974.

Key Words: epidemiology, mercury.

Abstract:

The largest known epidemic of methylmercury poisoning occurred recently in Iraq during a 2-month period in which 6,530 cases were hospitalized. There were 459 hospital deaths. The source was homemade bread prepared from seed wheat treated with a methylmercurial fungicide. Both sexes of all ages were affected. Children (1-9 yr) constituted 34% of admissions. Of 31 pregnant women who were hospitalized, 14 died. Follow-up studies of infants exposed in utero and by suckling are currently in progress. A mouse model has been developed for evaluating the risk to the mammalian fetus and newborn. Thus far it has been shown that: methylmercury passes freely from mother to fetus; newborn mice ingest and absorb significant amounts of mercury when suckled by mercury-dosed mothers; suckling mice excreted mercury at rates less than 1% of adult excretion rates. These observations have been useful in designing and initiating human investigations and treatment.

Domenowske, R.S. and R.I. Matsuda.

Sludge Disposal and the Marine Environment.

JWPCF. 41(9):1613-1624. September 1969.

Key Words: BOD, surface water (marine).

Abstract:

No measurable sludge deposition was observed in the vicinity of the West Point plant outfall and diffuser. The biological fauna observed in the immediate vicinity of the outfall appear normal in both numbers present and reaction to effluent from the diffuser jets.

No effect of effluent or sludge disposal on primary productivity can be demonstrated (with the Carbon-14 method) in Puget Sound because of the extreme daily fluctuations in productivity values.

While it is possible that the effluent and sludge are contributing to natural sedimentation in the deeper portions of Puget Sound, such contributions are presently undefinable since these areas have been receiving natural sediment since glacial times and probable sediment from dredge spoils in recent years.

Minor variations in the benthic fauna have been observed, but the numbers and areas involved are sporadic, and caution must be used in subsequent interpretations. In any event, no substantial change has been recorded in benthic population examined to this time.

Dotson, G.K.

Some Constraints of Spreading Sewage Sludge on Cropland.

Compost Science. 14(6):12-15. November-December 1973.

Key Words: ammonia, nitrates, phosphates, boron, cadmium, chromium, cobalt, copper, lead, nickel, zinc, virus, bacteria, agriculture.

Abstract:

Zinc, copper, and nickel are most likely to build up toxic levels as a result of sludge spreading. Other metals that may be present in sludge in excess include chromium, cadmium, lead, and mercury. The most important factors influencing the survival time of intestinal pathogens were type of organism, soil type, moisture, temperature, pH, and the presence of antagonistic organisms in the soil.

Dowty, B., D. Carlisle, and J.L. Lester.

Halogenated Hydrocarbons in New Orleans Drinking Water and Blood Plasma.

Science. 187:75-77. January 1975.

Key Words: epidemiology, drinking and recreational water.

Abstract:

Volatile organics from New Orleans drinking water and pooled plasma were collected on a solid phenyl ether polymer and analyzed by gas chromatographic and mass spectrometric techniques. Thirteen halogenated hydrocarbons were identified in the drinking water. Five halogenated compounds were found in the plasma. Tetrachloroethylene and carbon tetrachloride were found in both the plasma and the drinking water. Considerable variation in the relative concentrations of the halogenated hydrocarbons was noted from day to day in the drinking water.

Draft Analytical Report: New Orleans Area Water Supply Study.

Lower Mississippi River Facility, Surveillance and Analysis Division, Region VI, U.S. Environmental Protection Agency, Dallas, Texas, 1974. 30p.

Key Word: drinking and recreational water.

Abstract:

A sampling and analytical survey was performed to determine the identities and concentrations of trace organic compounds which might be present in the finished water supply for New Orleans. The study did not encompass an evaluation of the public health significance of the results. Trace organic compounds or organic isomers of undetermined specific structure which were identified are listed with their highest concentrations.

Dredge Disposal Study San Francisco Bay and Estuary, Appendix H: Pollutant Uptake Study.

U.S. Army Engineer District, San Francisco, September 1975. 157p.

Key Words: arsenic, cadmium, copper, mercury, nickel, lead, selenium, zinc.

Abstract:

This is a study on the uptake of heavy metals by marine invertebrates.

Dreisbach, R.H.

Handbook of Poisoning: Diagnosis and Treatment.

Lange Medical Publications, Los Altos, Calif. 1971.

Key Word: epidemiology.

Abstract:

This is a handbook on poisoning from and toxicity of a variety of chemicals and heavy metals and includes discussions on symptoms, diagnosis, and treatment.

Drewry, W.A. and R. Eliassen.

Virus Movement in Groundwater.

JWPCF. 40(8):R257-R271. August 1968.

Key Words: viruses, direct contact, groundwater.

Abstract:

1. Bacterial viruses can serve as useful tools toward understanding the mechanisms involved in the movement of virus particles through porous media such as subsurface waste disposal systems. However, there are limitations on the adequacy of bacterial viruses serving as models for animal viruses. These limitations must be recognized and taken into consideration in the interpretation of any work where bacterial viruses are used as models for animal viruses.

2. Virus retention by soils is an adsorption process and is affected to a greater or lesser extent by many environmental conditions. The adsorption processes observed in this study are characterized by linear adsorption isotherms.

3. Virus adsorption by soils is greatly affected by the pH of the water-soil system. This effect is due primarily to the amphoteric nature of the protein shell of the virus particles. At lower pH values, below 7.0 to 7.5, virus adsorption is rapid and effective to a high degree. Higher pH values considerably decrease the effectiveness of virus adsorption by soils because of increased ionization of the carboxyl groups of the virus protein and increasing negative charge on the soil particles.

4. Virus adsorption by some soils is greatly enhanced by increasing the cation concentration of the liquid phase of a soil-water system. The cations present in the water neutralize or reduce the repulsive electrostatic potential (the negative charge) on either the virus particles or the soil particles or both and allow adsorption to proceed.

5. The ability of a soil to adsorb virus particles cannot be judged on the basis of the various tests which normally are used to characterize a soil. In general, this study indicates that adsorption of virus particles by soils increases with increasing clay content, silt content, ion-exchange capacity, and glycerol-retention capacity.

6. Radioisotope-tagged viruses provide a means for determining almost instantaneous distribution patterns in continuous-flow column experiments without disturbing the column material or the flow patterns within the column.

7. Virus movement through soils under saturated conditions should present no great hazard with respect to underground water supplies. This conclusion would, of course, be limited to continuous strata of common soils such as those used in this study. This conclusion also is contingent on usual public health practices of placing water wells at least 100 to 150 ft (30 to 46 m) from septic tank or cesspool drain fields.

Driver, C.H., B.F. Hrutfiord, D.E. Spyridakis, E.B. Welch, and D.D. Wooldridge.

Assessment of the Effectiveness and Effects of Land Disposal Methodologies of Waste Water Management.

University of Washington, Seattle for U.S. Army Corps of Engineers, January 1972. 166p. (Available from National Technical Information Service (NTIS) as AD-A019 847).

Key Words: BOD, suspended solids, nitrates, phosphates, elemental contaminants, synthetic/organics, viruses, bacteria, ponding/land applications.

Abstract:

This is a state-of-the-art evaluation of the environmental impacts associated with secondary treated waste water disposal by spray irrigation, rapid infiltration ponds, and overland runoff.

Drummond, R.A., G.F. Olson, and A.R. Batterman.

Cough Response and Uptake of Mercury by Brook Trout, *Salvelinus fontinalis*, Exposed to Mercuric Compounds at Different Hydrogen-ion Concentrations.

Transactions of the American Fisheries Society. 103:244-249. April 1974.

Key Words: mercury, fish.

Abstract:

The uptake of mercury by brook trout exposed to mercuric chloride did not differ at pH 6.0 and 9.0.

Dube, D.J., G.D. Veth, and G.F. Lee.

Polychlorinated Biphenyls in Treatment Plant Effluents.

JWPCF. 46(5):966-972. May 1974.

Key Words: chlorinated hydrocarbons, effluent characteristics.

Abstract:

The results of this study indicate that 6 of the 11 wastewater treatment plants in the study had effluent concentrations in the range of 0.1 to 0.5 μg/l of a compound whose chromatogram appeared to match the chromatogram of Aroclor 1254. Two sites had effluent concentrations greater than 1.0 μg/l of equivalent Aroclor 1254. One city had a maximum concentration of 42 μg/l of equivalent Aroclor 1248 in the effluent waters and 5.2 mg/l of equivalent Aroclor 1248 in the digester sludge.

Data from the Cedarburg treatment plant show that the time of collection is important because the concentration can vary greatly. The data show that the minimum concentrations of PCB's in the Cedarburg plant are probably 0.13 to 0.30 μg/l of equivalent Aroclor 1254, while maximum concentrations range from 1.5 to 3.1 μg/l. Because of hourly fluctuations, it is difficult to determine precisely the total amount of PCB's being discharged into receiving waters without hourly sampling of the effluent at a given site.

Of the various samples of waste effluents collected, the estimated mass transport of PCB's varied from $< 0.2 \times 10^{3-}$ to $142 \times 10^{3-}$ lb/day ($0.9 \times 10^{4-}$ to $64.5 \times 10^{3-}$ kg/day). At Racine, an equivalent of 41.1 lb PCB/yr (18.7 kg/yr) flowed into the near shore waters of Lake Michigan.

Based on the study at the Cedarburg plant, it seems that the treatment of domestic waters removes 70 percent or more of the PCB's (Aroclor 1254) present in incoming wastes. The fact that most of the PCB's are removed by treatment is also evident in the comparatively high concentration of PCB's found in the digester and primary settling sludges.

Duboise, S.M., B.P. Sagik, and B.E.D. Moore.

Virus Migration through Soils.

In: Virus Survival in Water and Wastewater Systems. J.F. Malina, Jr., and B.P. Sagik, eds. University of Texas at Austin, Center for Research in Water Resources, 1974. pp. 233-240.

Key Words: viruses, polio virus, ponding/land application, land reclamation.

Abstract:

Both continuous and intermittent flow experiments indicate that T7 and poliovirus I are not absorbed rapidly enough to prevent breakthrough. Both viruses have been found in the eluent in infectious form after four days. A marked difference between continuous and intermittent flow data with T7 was observed. Much less T7 per volume unit passed through the columns under intermittent flow conditions than with continuous flow. Such a difference is not as marked with poliovirus I. It cannot be said with confidence at this time that such a difference exists at all using polio. The continuous flow columns suggest that in this soil, more polio I than T7 adsorbs in the initial period after virus application. Considering that T7 is considerably larger than polio I, the continuous flow data indicate that adsorption phenomena probably have more impact upon virus migration through this soil than do any hindrances due to size.

The implications of this data for terrestrial waste disposal projects are rather limited since water was used as eluent instead of treated sewage effluent and much larger quantities of virus were used than would be found under the conditions of irrigation projects. The data should, however, give some indication of what might happen to some viruses in relatively pure ground water. The T7 data suggest that use of irrigation systems spread over large areas and operating in a very intermittent fashion might be highly advantageous to maximize virus adsorption by the soil.

Duddles, G.A., S.F. Richardson, and E.F. Barth.

Plastic-Medium Trickling Filters for Biological Nitrogen Control.

JWPCF. 46(5):937-947. May 1974.

Key Words: ammonia, nitrates, nitrites, trickling filters.

Abstract:

An overview of this study indicates that the nitrifying plastic-medium trickling filter is a stable unit process, capable of producing a high-quality effluent, even under adverse conditons. Because final clarification may not be required after the trickling filter and because of the ease and low cost of trickling filter operation, the economics of this process compare favorably with those of other biological or chemical-physical systems for nitrogen control. Based on the actual performance results of this study, the preliminary design guidelines are summarized as follows. This information is dependent on key variables such as temperature, seasonal regulatory requirements, carbonaceous loadings, and the absence of inhibiting toxicity.

Duedall, I.W., H.B. O'Connors, and B. Irwin.

Fate of Wastewater Sludge in the New York Bight Apex.

JWPCF. 47(11):2702-2706. November 1975.

Key Words: adeno virus, *Staphylococcus aureus*, *Clostridium botulinum*, surface water (marine).

Abstract:

The objectives of this report are (a) to report some values for the total organic carbon (TOC), organic nitrogen (ON), total carbohydrate (TCH), and caloric content of dried sludge, and (b) to make some inferences as to the fate of ocean-dumped sludges based on the sludge analyses, some preliminary carbon and nitrogen analyses of sediment from the apex, and recently reported *in situ* oxygen utilization observations in sediments underlying a sludge disposal area.

Dugan, G.L., R.H.F. Young, P.C. Ekern, and P.C.S. Loh.

Land Disposal of Sewage in Hawaii a Reality?

Water and Sewage Works. 121(11):64-65. November 1974.

Key Words: ammonia, nitrates, phosphates, total dissolved solids, viruses.

Abstract:

The feasibility of sewage effluent application in irrigation of grassland and sugarcane culture is under study on Oahu, Hawaii. Facilities employed for the project included the construction of several 5-ft. (1.5 m) deep field lysimeters with surface coverings of Bermuda grass, sugarcane, and also bare soil; and the sampling of leachate collected from sugarcane fields being irrigated with secondary effluent and ditch water.

Dugan, G.L., R.H.F. Young, L.S. Lau, P.C. Ekern, and P.C.S. Loh.

Land Disposal of Wastewater in Hawaii.

JWPCF. 47(8):2067-2087. August 1975.

Key Words: BOD, suspended solids, ammonia, nitrates, nitrites, phosphates, total dissolved solids, total organic carbon, boron, viruses, leptospirosis, *Escherichia coli*, *Vibrio cholerae*, polio virus, fecal streptococci, activated sludge, chlorination, ponding/land application, crops, effluent characteristics.

Abstract:

In order to consider seriously the use of land treatment and disposal or the utilization of wastewater effluent and to develop information to supplement a water quality management plan for Oahu, the city and county of Honolulu sponsored a study to determine the feasibility of wastewater effluent application by the irrigation of grassland and sugar cane culture and to ascertain the probable effect on groundwater quality, particularly in terms of dissolved solids and enteric virus transmission and survival.

Dugan, P. R.

Bioflocculation and the Accumulation of Chemicals by Floc-Forming Organisms.

EPA-600/2-75-032, Ohio State University, Columbus, Dept. of Microbiology, September 1975. 152p. (Available from National Technical Information Service (NTIS) as PB-245 793).

Key Words: cobalt, iron, nickel, aldrin, activated sludge.

Abstract:

Several floc-forming bacteria were isolated from polluted water by this and other laboratories. All organisms studied produced extracellular polymer fibrils that were related to flocculation. The extracellular polymers have high adsorption capacity for: soluble metal and other mineral ions, soluble organic nutrients (BOD), soluble toxic organics, insoluble mineral particles and insoluble organic particulates. The bacteria remove BOD by physical adsorption as well as by oxidative metabolism and can convert oxygen demanding organics to more extracellular polymer. Production of polymer can be stimulated nutritionally to yield amounts that have waste treatment-pollution abatement potential on a commercial scale. The relationship of bioflocculation to waste treatment and lake eutrophication is discussed and the basic mechanism of bioflocculation is considered. Biochemical activity of individual floc-forming cells is examined because of its relevance to polymer synthesis. Taxonomy of floc-formers is also considered in relationship to biochemical activities.

Dunbar, D.D. and J.G.F. Henry.

Pollution Control Measures for Stormwater and Combined Sewer Overflows.

JWPCF. 38(1):9-26. January 1966.

Key Words: BOD, suspended solids, bacteria, combined municipal/stormwater systems.

Abstract:

Studies of 5-day BOD, suspended solids, and coliform concentrations in mixed stormwater and raw sewage discharges leave little doubt that combined sewer outfall works are an important source of water pollution.

Dunham, J., R.W. O'Gara, and F.B. Taylor.

Studies on Pollutants from Processed Water: Collection from Three Stations and Biologic Testing for Toxicity and Carcinogenesis.

Public Health. 57(12):2178-2185. December 1967.

Key Words: epidemiology, drinking and recreational water.

Abstract:

Pollutants in drinking water, adsorbed on carbon filters and eluted by chloroform and by alcohol, were collected for one year from the supply of New Orleans, La., which had a high bladder cancer incidence, and from two stations supplying Birmingham, Ala., which had a low bladder cancer incidence. The water from all three sources had been processed for human consumption before being passed through the carbon filters. The toxicity of extracts of pollutants was studied by subcutaneous injection in newborn albino mice. The carcinogenicity of extracts, administered at tolerated doses, was tested by the same method. Tumors attributable to the pollutants were not induced in the tissues examined, including the bladder, during the experimental period of 78 weeks.

Pollution of drinking water by chemicals and some aspects of detection of carcinogenic pollutants are briefly discussed. The question of whether drinking water contains agents that can produce cancer in man is still undetermined and requires further study.

Dunlap, W.J., R.L. Cosby, J.F. McNabb, B.D. Bledsoe, and M. R. Scalf.

Investigations Concerning Probable Impact of Nitrilotriacetic Acid on Ground Water.

Robert S. Kerr Water Research Center, Ada, Oklahoma, November 1971. 59p. (Available from National Technical Information Service (NTIS) as PB-208 433).

Key Words: synthetic/organics, air, direct contact, groundwater.

Abstract:

Laboratory studies were employed to investigate the fate and effect of NTA both in ground waters and in soil profiles overlying ground waters.

Studies of the sorption of NTA by sand, loam, and clay-loam soils indicated that sorption of NTA on soils could slow its movement into and through ground waters. Sorption will probably not be sufficient to prevent or greatly reduce potential pollution of ground water by NTA used as a detergent builder.

Soil column studies were employed to investigate the degradation and effect on metals of NTA infiltrating through soils. These studies indicated: NTA infiltrating through most unsaturated soils likely would undergo rapid and complete degradation and contribute only inorganic nitrogen compounds and carbonate to ground waters; NTA infiltrating through saturated soils would probably experience only very limited degradation, with a major portion entering ground water intact; any NTA which escaped degradation during infiltration through soils could transport such metals as iron, zinc, chromium, lead, cadmium, and mercury from soils into ground waters.

Studies with model aquifers constructed from natural aquifer sand indicated that NTA would likely undergo slow degradation in essentially anaerobic ground-water environments, with production of CO_2, CH_4, and possibly other organic compounds.

Dunlop, S.G.

Survival of Pathogens and Related Disease Hazards.

In: Municipal Sewage Effluent for Irrigation. C.W. Wilson and F.E. Beckett, eds. Agricultural Engineering Department Symposium, Louisiana Polytechnic Institute, Ruston, La., 1968. pp. 102-122.

Key Words: salmonella, shigella, parasitic worms, coliforms, polio virus, coxsackie virus, ECHO virus, hepatitis virus, leptospirosis, crops.

Abstract:

This is an excellent review on the topic matter. Literature is very conveniently structured in chart form.

Dunstan, W.M.

Problems of Measuring and Predicting Influence of Effluents on Marine Phytoplankton.

Environmental Science and Technology. 9(7):635-638. July 1975.

Key Words: ammonia, nitrates, nitrites, phosphates, copper, iron, nickel, zinc, surface water (marine), effluent characteristics.

Abstract:

Concentrations of nitrogen (N) and phosphorus (P) in sewage effluents are high enough to increase the levels of these nutrients in coastal waters and thereby to influence phytoplankton ecology. A variety of algae cultured in several samples from one treatment plant failed to grow to the levels that would be predicted based on the N and P concentrations. Effluents from other treatment plants were even less predictable. Furthermore, different groups of algae and species within these groups varied in their response to different effluents which were matched in N and P concentrations. Effluent from one plant which produced deficient growth, based on the N and P concentrations, grew to expected levels when trace metals were added to the effluent. While N and P added to the coastal environment from sewage effluent stimulates general phytoplankton growth, the addition of effluents emphasizes the role of minor growth substances which might otherwise not have been important in the N-limited coastal region. These factors then become important in causing changes in the pattern of phytoplankton production, distribution, and population dynamics.

Durston, W.E. and B.N. Ames.

A Simple Method for the Detection of Mutagens in Urine: Studies with the Carcinogen 2-Acetylaminofluorene.

Proceedings National Academy of Sciences. 71(3):737-741. March 1974.

Key Word: epidemiology.

Abstract:

This article describes an application of the Ames test for the detection of mutagenic metabolites in urine.

Durum, W.H. and J.D. Hem.

An Overview of Trace Element Distribution Patterns in Water.

Annals New York Academy of Science. 199:26-36. June 28, 1972.

Key Words: arsenic, cadmium, lead, surface water (fresh).

Abstract:

This article gives levels of trace element distribution in surface water throughout the United States.

Eastman, P.W.

Municipal Wastewater Reuse for Irrigation.

Journal of the Irrigation and Drainage Division, ASCE.
93(IR3):25-31. September 1967.

Key Words: BOD, suspended solids, groundwater.

Abstract:

In the arid and semi-arid part of the United States, the reclamation of water from municipal sewage is becoming increasingly recognized as an important water conservation measure as well as a means of preventing and abating pollution of streams and other receiving waters. As the costs of water supply development increase with the distance of transport or other factors, renovation or upgrading the quality of wastewater for direct reuse becomes economically attractive and, in fact, almost imperative. Land application of treated wastewater for crop irrigation or other purposes is an increasingly desirable pollution control alternative to discharge of treated wastes to streams, etc. As waste loads increase, the residual loads after present day conventional complete treatment (85% to 90% removal of suspended solids and oxygen demanding organics and 35% to 50% removal of nutrients) will in many cases overtax the assimilative ability of streams and other water bodies.

Eaton, F.M.

Chlorine.

In: Diagnostic Criteria for Plants and Soils. H.D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 98-135.

Key Words: chlorides, ponding/land application, land reclamation, groundwater, crops.

Abstract:

Chlorine is the most recent element to be confirmed as essential to the growth of plants. The author gives symptoms of chloride deficiency and excess and the use of tissue analysis data in diagnosing chloride status. He also discusses chloride in rain water and soils and the control of chloride deficiency and excess with special emphasis on the experience of the Netherlands with chloride toxicity, as a result of the inundations of polders during the Second World War. He concludes with remarks on the chloride tolerance of plants as measured in sand and water cultures as well as their tolerance to total salt.

Eberhardt, W.A. and J.B. Nesbitt.

Chemical Precipitation of Phosphorus in a High-Rate Activated Sludge System.

JWPCF. 40(7):1239-1267. July 1968.

Key Words: phosphates, adsorption/ion exchange.

Abstract:

In view of the experimental findings of the present study and of previous related work it can be concluded that:

1. Essentially complete removals of soluble phosphorus are attainable by the combined biological-chemical process studied. The removal efficiency depends on pH and the Al:P molar ratio. In this study an Al:P ratio of 1.5 to 2.1 was necessary to effect almost complete removals.

2. Without filtration, the phosphorus content of the combined process effluent depends on both soluble levels and suspended solids concentrations. For the domestic wastewater investigative conditions an aluminum sulfate dosage greater than that necessary to produce a low soluble residual was required for satisfactory flocculation and clarification.

3. The biological performance of the activated sludge as measured by soluble organic substrate removal was not affected adversely by additions of aluminum sulfate as high as 335 mg/l. Moreover, the aluminum sulfate itself did not effect significant removals of soluble BOD_5 or LAS.

4. The addition of aluminum sulfate favorably decreased the SVI of the HRAS mixed liquor.

5. In addition to significantly increased phosphorus removals, the biological-chemical process investigated offers the advantages of increased BOD_5 (unfiltered effluent) and suspended solids removals over those of an HRAS process operating under similar conditions without aluminum sulfate addition. The former process at optimum chemical dosage would produce more sludge by weight and less sludge by volume.

6. The BOD_5 (unfiltered effluent) and suspended solids removals of the combined process under the conditions of the present study and a typical conventional activated sludge process would be approximately the same. The volumes of sludge produced by the two also would be similar, whereas the former process would produce a greater weight of sludge. The combined process, naturally, would produce significantly lower phosphorus residuals.

7. The combined process does not require a separate flocculation basin for effective performance. With domestic wastewater, however, the point of chemical application and time of flocculation require consideration.

8. The theoretical aeration period required by the biological-chemical process investigated is from one third to one half that typically used with conventional activated sludge. The savings realized from the decreased detention time will at least partially offset the costs of chemical treatment.

9. The conventional MLVS parameter was not an acceptable measure of biological mass in the biological-chemical system investigated.

10. In both the HRAS and combined biological-chemical systems studied, the LAS removals were excellent and essentially equal to the associated BOD_5 removals.

Eckenfelder, W.W., Jr.

Wastewater Treatment Design: Economics and Techniques - Part I.

Water and Sewage Works. 122(6):62-65. September 1975.

Key Words: ammonia, BOD, COD, nitrates, phosphates, total dissolved solids, activated sludge, surface water (fresh).

Abstract:
This article discusses the techniques and cost of biological treatment plants.

The Ecology of the Southern California Bight: Implication for Water Quality Management.

SCCWRP TR104. Southern California Coastal Water Research Project, El Segundo, California, March 1973.

Key Words: iron, nickel, chlorinated hydrocarbons, total organic carbon, zinc, manganese, chromium, cadmium, copper, cobalt, lead, mercury, surface water (marine), shellfish, fish.

Abstract:

Discussed are the distribution of metals and chlorinated hydrocarbons in water, sediments, and fauna of the Southern California Bight, and characteristics of a wastewater treatment effluent entering the area for general contaminants, metals, chlorinated hydrocarbons, and PCB's.

Edmisten, J.A.

Agricultural Utilization of Digested Sludges from the City of Pensacola.

In: Municipal Sludge Management; Proceedings of the National Conference on Municipal Sludge Management, 1974. pp. 177-182.

Key Words: aluminum, iron, manganese, copper, zinc, chromium, lead, nickel, mercury, cadmium, boron, arsenic, cobalt, molybdenum, selenium, ammonia, nitrates, nitrites, phosphates, crops, effluent characteristics.

Abstract:

This article lists data on crops grown in sludge.

Edwards, V.H. and P.F. Schubert.

Removal of 2, 4-D and Other Persistent Organic Molecules from Water Supplies by Reverse Osmosis.

JAWWA. 66(10:610-616). October 1974.

Key Words: pesticides, DDT, suspended solids, viruses, bacteria, herbicides, tertiary treatment.

Abstract:

Re:concentration of pesticides or other refractory organics in water prior to analysis. As does adsorption on active carbon and solvent extraction, reverse osmosis shows varying selectivity for pesticide residues depending on the residue, residue concentration, membrane, and the presence of other solutes. Retentions are higher in some cases and lower in others than those obtainable with the competitive sample-concentration methods of adsorption or of solvent extraction.

Pesticides such as DDT with very low aqueous solubilities, which form colloidal particles, aggregates, micelles, or macro-molecules, are more efficiently removed than compounds such as 2,4-D, which is sparingly soluble, or phenol, which is highly soluble in the membrane. Vapor pressure and many other variables also may be correlating factors.

Reversible sorption of the solute by the membrane appears to be important in a significant number of instances tested for this report, as well as a number of cases in the literature. Very high membrane sorption and coupled solvent-solute flow appear to account for the negative rejections of organics such as phenol. Conversely, irreversible sorption of a pesticide by a membrane has not been reported in the literature.

Reverse osmosis remains a candidate for water-sample concentration prior to pesticide analysis, especially because 2,4-D is somewhat atypical in its aqueous solubility (and perhaps also in its membrane permeability); also, reverse osmosis is a method that concentrates both dissolved and suspended solids. However, additional study of the removal of

pesticides and other refractory organics by reverse osmosis is needed.

Regarding the purification of natural or reuse water, reverse-osmosis membranes remove bacteria and viruses quantitatively in the absence of membrane defects. This could be a significant advantage in schemes for reuse of treated domestic wastes or the use of low-grade water supplies. Conductivity measurements could be used to detect membrane defects. Chlorination of ozonation would still be required, but quantity might be reduced by lower levels of coliforms, organics, and ammonia in the water to be treated.

Eganhouse, R.P. Jr.

Mercury in Sediments.

Southern California Coastal Water Research Project.
Annual Report. El Segundo, Calif., June 30, 1976. pp.83-90.

Key Words: mercury, surface water (marine).

Abstract:

Results show that levels of total mercury in the surface sediments on the Palos Verdes shelf dropped slightly between 1972 and 1975, although the exact cause of this decrease is still uncertain. Organic mercury, consituting up to 2.3 percent of the total mercury in Palos Verdes sediments, appears to have been concentrated in the regions where total mercury values were highest, except for two stations near the outfalls, where organic values dropped. The highest level observed for total organic mercury was 0.021 μg/dry g. Data on the relationship between total volatile solids and total mercury showed that mercury in the surface sediments is probably trapped in the refractory component and is largely unavailable to the benthic animals.

The Project's studies of mercury are reviewed in a technical memorandum released this year (Eganhouse _et al_. 1976). Studies are now underway to determine how the metal is partitioned among the various sediment phases.

Eganhouse, R.P., Jr. and D.R. Young.

Mercury in Benthic Animals.

Southern California Coastal Water Research Project.
Annual Report. El Segundo, Calif., June 30, 1976. pp. 111-116.

Key Words: mercury, air, direct contact, shellfish, fish.

Abstract:

The survey involved collection and analysis of tissues from Dover sole, crab, prawn, snail, urchin, and sea slug. The levels of total mercury are very low with none exceeding U.S. FDA guidelines. Organic mercury constitutes the major fraction of the total mercury in muscle tissues of sole, crab, and prawn. The tissue mercury content seemed to be independent of sediment mercury values, suggesting that the mercury in the sediments is largely unavailable to benthic organisms.

Eganhouse, R.P., Jr. and D.R. Young.

Mercury in Mussels.

Southern California Coastal Research Project.Annual
Report. El Segundo, Calif., June 30, 1976. pp. 105-110.

Key Words: mercury, shellfish.

Abstract:

The results of these experiments demonstrate the value of *M. californianus* as an environmental bioindicator. Our studies showed that, of the three tissues analyzed, digestive gland contained the highest levels of mercury and experienced the fastest uptake. Adductor muscle and gonadal tissues had markedly slower accumulation rates. These results tend to support the idea that digestive gland analyses reflect environmental mercury levels, but that adductor muscle and gonadal tissues are more accurate indicators of the extent of physiological incorporation. The digestive gland mercury concentrations appear to reflect relatively short-term changes in the environment. The gradual accumulation of mercury in adductor muscle and gonadal tissues, however, appears to result primarily from a chronic exposure to mercury.

Egeland, D.R.

Land Disposal I: A Giant Step Backward.

JWPCF. 45(7):1465-1475. July 1973.

Key Words: tertiary water treatment, land disposal.

Abstract:

In the short span of four years, the practice of land disposal has been raised from near extinction to a position of national eminence. Enthusiasts for land disposal seemingly are unaware that past experience and current research quite clearly indicate that continuous application of modern wastewater to large areas of land will ultimately work havoc on the fragile, thin skin of soil that covers the earth and could permanently contaminate critical groundwater supplies. The danger posed by land disposal is not so much the threat of devastating land and water, however, for surely that will never come to pass; the real danger is that enormous amounts of limited funds, critical time, valuable human resources, and irreplaceable energy resources could be wasted on false starts into obsolete technologies that at the outset did not hold forth a complete or viable solution to the problem while far more promising programs are aborted.

Fortunately, the wastewater technology professionals continue to meet the crises of the day and proceed methodically toward their goal of selective separation and useful recycling of wastewater resources. Demeaned by a Senate committee, discredited by the Army, maligned by youthful consumer advocates, ridiculed in popular journals, and hampered by a lack of adequate research funds, these professionals are nevertheless hammering out a standard pollution profile and seem to be on the verge of dramatic breakthroughs in their quest for methods of treatment that will be ecologically beneficial and economically profitable, and which will place minimum demands on the nation's natural and energy resources.

Ehrlich, G.G., T.A. Ehlke, and J. Vecchioli.

Microbiological Aspects of Ground-Water Recharge -- Injection of Purified Unchlorinated Sewage Effluent at Bay Park, Long Island, New York.

U.S. Geological Survey Journal of Research. 1:341-344. May 1973.

Key Words: bacteria, surface water (fresh).

Abstract:

Unchlorinated, tertiary-treated sewage effluent was injected through a well at Bay Park, Long Island, N.Y., into a sand aquifer at a rate of 340 gpm for 10 days. Massive, biologically produced slime deposits formed in the filter pack immediately adjacent to the well screen. Observed head buildup in the recharge well was correlated with the formation of these deposits. Comparison of results from this test with results of earlier tests suggests that formation of these deposits may be avoided by addition of chlorine to the injectant.

Eichelberger, J.W. and J.J. Lichtenberg.

Persistence of Pesticides in River Water.

Environmental Science and Technology. 5:541-544.
June 1971.

Key Words: aldrin, dieldrin, DDE, DDD, DDT, endrin, chlorinated hydrocarbons, organophosphorous pesticides, surface water (fresh).

Abstract:

The persistence of 28 common pesticides in raw river water was studied over an eight-week period. Twelve organochlorine, nine organophosphorus, and seven carbamate pesticides were studied at a concentration of 10 μg/liter. No measurable degradation or chemical change was observed for the following organochlorine compounds: BHC, heptachlor epoxide, dieldrin, DDE, DDT, DDD, and endrin. Azodrin was the only organophosphorus compound that was stable through the study. All carbamate compounds were significantly changed after one week, and all but Baygon were completely lost after eight weeks. Where possible, the degradation or chemical conversion products of the pesticides were identified.

Eliassen, R. and G. Tchobanoglous.

Chemical Processing of Wastewater for Nutrient Removal.

JWPCF. 40(5):R171-R180. May 1968.

Key Words: ammonia, nitrates, nitrites, adsorption/ion exchange, nitrification/denitrification, chemical treatment.

Abstract:

Nutrients are compounds capable of stimulating the growth of algae and other aquatic plants. Interest in these compounds and substances stems from the adverse effects of their presence in water and wastewater.

Nutrient-removal methods may be classified as biological, chemical, and physical. Chemical methods for the removal of nitrogen include ammonia stripping, ion exchange, and electrochemical treatment. Chemical methods for the removal of phosphorus include chemical precipitation, ion exchange, sorption, and elecrochemical treatment. Typical removal efficiencies are 80-98 percent and 85-99 percent for nitrogen and phosphorus compounds, respectively.

In planning and designing facilities to be used for nutrient removal the key factors which must be considered are: (a) the nutrient or nutrients to be removed, (b) the use to be made of the treated wastewater -- this will normally govern the required nutrient-removal efficiency, (c) the available means for disposing of the ultimate contaminants, and (d) the economic feasibility.

Eliassen, R. and G. Tchobanoglous.

Removal of Nitrogen and Phosphorus from Wastewater.

Environmental Science and Technology. 3:536-541.
June 1969.

Key Words: nitrates, phosphates, trickling filter, chemical treatment, adsorption/ion exchange, nitrification/denitrification, ponding/land application.

Abstract:

This article is a good overview on the removal of nutrients from wastewater.

Eliassen, R., B.M. Wyckoff, and C.D. Tonkin.

Ion Exchange for Reclamation of Reusable Supplies.

JAWWA. 57(9):1113-1122. September 1965.

Key Words: phosphates, chlorides, COD, adsorption/ion exchange.

Abstract:

Among the several treatment processes used at the Water Reclamation Demonstration Plant at Stanford University, the ion-exchange process appears to have the most potential for effective tertiary treatment to recover reusable water from municipal waste waters. Inorganic material, such as nitrogen and phosphorus compounds as well as organic material can be removed in one operation providing that filtration precedes the ion-exchange process.

Water suitable for many purposes, including surface storage, can be produced at a cost competitive with existing supplies in high-cost areas. Diatomaceous-earth filtration, followed by anion exchange, can be accomplished at a cost of about 21 cents per 1,000 gal, including all plant costs for operation, maintenance, and capital recovery. All work has been done at Palo Alto, where treated sewage has a relatively high chloride content resulting from infiltration. Results should be better and costs should be lower under more favorable conditions.

Although water reclaimed with ion exchange will still contain some phosphorus and nitrogen compounds, the problem of algae growth in reservoirs will be greatly minimized. A lesser degree of nutrient removal, and consequent lower-cost treatment, would suffice for recharge of reclaimed waters to the ground. Reusable water is an added resource which the water utility profession must consider in water-short areas.

Ellis, B.G.

The Soil as a Chemical Filter.

In: Conference on Recycling Treated Municipal Wastewater Through Forest and Cropland. W.E. Sopper and L.T. Kardos, eds. EPA-660/274-003, Pennsylvania State University, University Park, Institute for Research on Land and Water Resources, March 1974. pp. 47-72.

Key Words: phosphates, boron, zinc, copper, iron, manganese, ponding/land applications, agricultural sludge disposal.

Abstract:

The soil has many times been referred to as "the living filter." But it serves as a chemical filter as well through the many organic and inorganic chemical reactions which occur when wastewater passes through the soil profile. In addition, the soil may chemically alter many of the materials which have been introduced into the profile by the addition of either wastewater or sludge. These alterations may lessen the environmental impact (for example, through conversion of organic materials to carbon dioxide thereby reducing the biological oxygen demand carried in the water) or may increase the environmental hazard (for example, through the conversion of organic nitrogen to nitrate, a much more hazardous material). Therefore, it is imperative that the soil chemistry be thoroughly understood and the various reactions used to optimize the "system" when applying waste to land so that environmental hazards will be at an absolute minimum.

In addition to purification of the wastewater passing through the soil profile, the accumulation of ions or compounds in the soil must not leave a residue which is harmful to either plant growth or to the animal or human consuming the crop. Our soil is a very precious resource. It must not be sacrificed in an effort to clean up our water resources.

The areas of soil chemistry which are of most importance for the soil to act as a chemical filter are: (1) ion exchange, (2) adsorption and precipitation, and (3) chemical alteration.

Ellis, B.G. and B.D. Knezek.

Adsorption Reactions of Micronutrients in Soils.

In: Micronutrients in Agriculture. R.C. Dinauer, ed. Soil Science Society of America, Madison, Wisconsin, 1972. pp. 59-78.

Key Words: copper, zinc, iron, aluminum, boron, manganese, ponding/land application, land reclamation.

Abstract:

Adsorption of micronutrients by soils and soil materials has been described by Freundlich or Langmuir equations. While both equations have been shown to describe adsorption of micronutrients under certain experimental conditions, neither is satisfactory under widely varying conditions. The need to relate quantity of adsorption and desorption of nutrients to levels in soil solution in order to control toxicities and deficiencies of micronutrients is self-evident.

Copper and Zn are known to exist as exchangeable ions and also to be bound by organic matter. The role of hydrolysis in their adsorption is still unclear. It has been suggested that hydrolysis of these cations near the clay surface may occur to a greater degree than in the bulk of the solution. But good evidence of this is lacking. Once these cations are adsorbed they may move into lattice positions in clay minerals. Conclusive evidence of solid-state diffusion is needed, and an evaluation of the rate of solid-state diffusion of Cu and Zn is not available.

The role of the oxides and hydroxides of Fe and Al in adsorption of B and Mo has been greatly clarified in recent years. In addition, limited data have been presented to substantiate the theory that B can be incorporated into tetrahedral layers of silicate minerals by solid-state diffusion. More investigations are needed to establish the rate of such diffusion and the influence of layer silicate species upon this mechanism. The theory developed by Hingston offers explanations for

the change in adsorption maximum with pH for weak acids. Although the data to verify this theory are limited for adsorption of B and Mo by a variety of adsorbing materials, it should add to our understanding of the mechanisms of adsorption of these ions.

Adsorption reactions of Fe and Mn have received relatively little attention in the past because precipitation reactions exert control of the level of these nutrients in solutions in most instances. Adsorption of Fe by montmorillonite and kaolinite has been shown to occur under acid conditions. It should also be expected that adsorption of both Fe and Mn under reducing conditions could occur. Limited data suggest that adsorption of Mn by organic matter may form complexes sufficiently stable to compete with precipitation as the mechanism controlling Mn levels in certain soils, particularly those high in organic matter. Considerable effort is needed to clarify the mechanisms of adsorption of Mn under these conditions.

Ember, L.

The Specter of Cancer.

Environmental Science and Technology. 9(13):1116-1121.
December 1975.

Key Words: general contaminants, elemental contaminants, pesticides, synthetic/organics, drinking and recreational water.

Abstract:

This article gives a general review of causes and consequences of carcenogens, and possible solutions for cure or arrestment of cancer.

Engineering Evaluation of Virus Hazard in Water.

Journal of the Sanitary Engineering Division, ASCE.
96(SA1)111-160. February 1970.

Key Words: viruses, hepatitis virus, polio virus, ECHO virus, coxsackie virus, trickling filters, surface water (fresh), shellfish, activated sludge, filtration, chlorination.

Abstract:

There is no doubt that the virus of infectious hepatitis can be transmitted by drinking water as can enteric viruses and other possible causative agents of viral gastroenteritis. A risk of infectious hepatitis infection results from consumption of raw or steamed underpurated shellfish taken from sewage polluted waters.

Inadequacy of methods for detecting, identifying, and enumerating viruses in samples of water still constitutes an important gap in water quality control. Current United States practice in the use of sewage effluent for irrigation purposes is acceptable in reducing risks of virus disease to an undetectable level.

England, B.

Recovery of Viruses from Waste and Other Waters by Chemical Methods

Developments in Industrial Microbiology. 15:174-183. 1973.

Key Words: viruses, chemical treatment, adsorption/ion exchange.

Abstract:

Concentration of virus particles in water and sewage samples before they are inoculated into cell cultures permits the recovery of viruses that otherwise would go undetected. Techniques currently available include viral adsorption to various substances, followed by viral desorption into a small volume of eluent. Early work in 1953 made use of an ion-exchange resin for adsorption of viruses, and subsequent years have seen methods developed for adsorption of viruses to, and elution from insoluble polyelectrolytes, iron oxide, and precipitate salts such as aluminum hydroxide and calcium phosphate. Eluents generally consist of alkaline buffers or solutions containing serum or other proteinaceous substances. Another technique that has found wide usage employs separation by aqueous polymer two-phase systems such as dextran and polyethylene glycol. Certain viruses can be concentrated from albumin-supplemented samples by treatment with protamine sulfate, the virus being recovered by dissolving the resultant precipitate in a small volume of sodium chloride. Most of these concentration methods are efficient and practical for sample volumes of several liters or less, quantities that suffice for testing raw sewage or grossly contaminated waters; few of the methods are applicable to the many-gallon samples necessary for testing highly treated, potable, or recreational waters.

England, B., R.E. Leach, B. Adams, and R. Shiosaki.

Virologic Assessment of Sewage Treatment at Santee, California.

In: Transmission of Viruses by the Water Route. G. Berg, ed. Wiley, New York, 1965. pp. 401-417.

Key Words: viruses, gravity separators, activated sludge, aerated lagoons, chlorination.

Abstract:

Recreational lakes for boating, fishing, and swimming have been developed at Santee, California, from water reclaimed from sewage. The series of processes employed by the treatment plant was assessed for viral removal. Primary settling was ineffective. Activated sludge treatment significantly decreased virus concentrations, but effected little reduction of the number of positive specimens. Nineteen percent of the specimens contained viruses after detention in an oxidation pond. Less than 10% of the chlorinated effluents from the oxidation pond yielded viruses. Percolation through a natural sand and gravel layer removed attenuated poliovirus in an experimental test. Over a 33-month period, no viruses were recovered from recreational lake samples.

Englebrecht, R.S., D.H. Foster, E.O. Greening, and S.H. Lee.

New Microbial Indicators of Wastewater Chlorination Efficiency.

EPA-670/2-73-082, University of Illinois-Urbana, Dept. of Civil Engineering, February 1974. 71p.

Key Words; bacteria, viruses, protozoa, _Escherichia coli_, chlorination.

Abstract:

The coliform group of indicator organisms has a relatively low resistance to chlorine when compared to pathogens such as enteric viruses and protozoan cysts. Consequently, an effort has been initiated to find a new chlorine resistant bioindicator of wastewater chlorination efficiency. A yeast and two different acid-fast bacilli were found to be resistant to chlorination in the range considered necessary for the inactivation of pathogens, including viruses. One acid-fast bacillus survived 2.0 mg/l free chlorine for 67 min while the other survived 1.0 mg/l free chlorine for 15 min. The yeast resisted 1.0 mg/l free chlorine for 20 min. In comparison, a pure culture of _E. coli_ failed to survive five min contact with 0.03 mg/l free chlorine. The chlorine resistance and other characteristics of the yeasts and acid-fast bacilli under study suggest that they show promise as bioindicators for wastewater chlorination for the more chlorine resistant pathogens.

English, J.N., C.W. Carry, A.N. Masse, J.B. Pitkin, and F.D. Dryden.

Denitrification in Granular Carbon and Sand Columns.

JWPCF. 46(1):28-42. January 1974.

Key Words: nitrates, filtration, adsorption/ion exchange.

Abstract:

Efficient denitrification (85 percent removal) of secondary effluent was promoted in small-scale carbon and sand columns containing media having a mean particle diameter of about 0.90 mm, at empty-bed detention times of less than 10 min, and by the addition of methanol to the column influent. Denitrification began in the carbon or sand within five days after beginning methanol feeding and was not adversely affected by backwashing. As a result of these findings and in an effort to capitalize on significant economies that may be achieved by combining denitrification with carbon adsorption, a large-scale study was conducted in a 4-stage, fixed bed, 0.3-mgd (1,140-cu m/day) granular activated carbon pilot plant to determine the efficiency of denitrification and its effect on column operation, COD removal efficiency, and carbon regeneration.

Supplementary nitrate was added to secondary effluent during two carbon column adsorption sequences to obtain average concentrations of 25.8 and 21.8 mg/l (NO_3-N). Results showed removals of 80 and 92 percent, respectively, with most of the denitrification occurring in the first stage (10-min detention time) and 3 to 4 mg/l (NO_3-N) removed, without methanol, in the subsequent stages. The methanol requirement was found to be 1.9 times the nitrate nitrogen removed plus 1.1 times the DO removed.

Denitrification in the 4-stage column showed no significant impairment of the carbon's ability to remove COD in either adsorption sequence. Removals of 72 percent of COD in the first sequence and 66 percent in the second were within the range of typical data developed during the 4 yr prior to initiating denitrification studies in the column.

High headlosses occurred in the first stage and were caused by increased biological growth. Backwashing was necessary twice daily, and, even with this frequency, headlosses averaged 30 to 50 psi (2.1 to 3.5 kg/sq cm) after less than 12 hr of operation. The biological growths also caused difficulties with dewatering the carbon and conveying it into the regeneration furnace. However, once the carbon entered the furnace it regenerated normally.

The total cost of a 10 mgd (37,850 cu m/day) denitrification plant using sand as the media was estimated at $71/mil gal ($18.80/1,000 cu m). If denitrification is combined with dissolved organic removal in an activated carbon system, the additional cost for denitrification was estimated to be $25/mil gal ($7/1,000 cu m).

English, J.N., K.D. Linstedt, and E.R. Bennett.

Research Required to Establish Confidence in the Potable Reuse of Waste Water.

Presented at the Water Pollution Control Federation Meeting, Miami Beach, Florida, October 9, 1975.

Key Words: ammonia, antibiotics, activated sludge, filtration, nitrification/denitrification, chemical treatment, chlorination, ozonation, radiation treatment, drinking and recreational water, surface water (fresh).

Abstracts:

It is anticipated that a program undertaking the research previously described will require a minimum of 10 to 15 years of intensive work to develop sufficient information to clearly define meaningful standards that can be applied with confidence to potable waters derived from a polluted source. These standards will have to be based on realistic public health considerations and have the support of public health officials at all government levels.

The goals of a direct or overt potable reuse program are similar to those of the present EPA Health Effects and Water Supply programs which have recently identified organic materials having potential health hazards in many of our nation's drinking waters. Some of these supplies contain appreciable quantities of wastewaters, and their use for domestic purposes can be classified as an indirect or covert form of potable reuse.

There was a general consensus of the Workshop attendees that the research identified must be addressed by both water supply and wastewater organizations. Even if direct reuse is not implemented, all the same questions which have been raised must be answered, and the technology must be developed to remove potential health hazard constituents present in our water supplies.

Any program of the magnitude required to alleviate the health concerns of both overt and covert potable reuse is not a local or even a national undertaking. International coordination is necessary since other nations such as South Africa, Israel, and some in the European community are facing deteriorating and unreliable water supplies, and are actively researching the problems involved with covert and overt potable reuse.

Enright, J.T., J.L. Gainer, and D.J. Kirwan.

Disinfection of Liquid and Aerosol Viral Systems Using Immobilized Enzymes.

Environmental Science and Technology. 9(6):586-588. June 1975.

Key Words: viruses, groundwater.

Abstract:

Inactivation of viruses contained in liquid and aerosol environments was achieved using enzymes immobilized on porous glass particles or ceramic supports. The viruses: Herpes simplex, Type 1; Coxsackie, A_{21}; and two strains of influenza A were tested. The nuclease corresponding to the nucleic acid of the respective virus was found to be the most effective immobilized enzyme for disinfection purposes. While liquid phase disinfection was considerably slower, disinfection of greater than 95% of the infectious airborne virus was attained with air contact times of 1 sec.

Environmentalists Urge EPA Action Against PCB Discharges on Hudson River.

Environment Reporter. Current Developments. 6(19):765. September 5, 1975.

Key Words: chlorinated hydrocarbons, surface water (fresh), fish.

Abstract:

EPA should take emergency action to halt the discharge from General Electric Company and other plants of PCB's into the Hudson River.

Epstein, E.

The Physical Processes in the Soil as Related to Sewage Sludge Application.

In: Recycling Municipal Sludges and Effluents on Land; Proceedings of the Joint Conference, July 9-13, 1973. pp. 67-73.

Key Words: total dissolved solids, land reclamation.

Abstract:

The physical processes in the soil are discussed with particular reference to sewage sludge application.

Adding sewage sludge initially increases the hydraulic conductivity of a soil, but the conductivity later decreases. This decrease appears to be due to clogging of soil pores by microbial decomposition products.

Soil structure affects soil water, soil air, mechanical impedence, and root distribution. Organic matter, through the activity of microorganisms, increases soil aggregation. Sewage sludge application increased the stable aggregates 16 to 33 percent.

The low oxygen and high carbon dioxide contents in the soil that result from high sludge application can reduce root growth, nutrient uptake, and plant growth. Other gas products of decomposition, such as methane and etheylene, can be detrimental to plants.

Erickson, A.E.

Physical Changes to Soils Used for Land Application of Municipal Waste -- What Do We Know? What Do We Need to Know?

In: Recycling Municipal Sludges and Effluents on Land; Proceedings of the Joint Conference, July 9-13, 1973. pp. 75-77.

Key Words: incineration, filtration.

Abstract:

This paper discusses generalities on what effects sludge, effluent, and sewage have on land for land disposal considerations; not greatly applicable to health effects.

Ericsson, B.

Nitrogen Removal in a Pilot Plant.

JWPCF. 47(4):727-740. April 1975.

Key Words: ammonia, nitrates, nitrites, nitrification/denitrification, chemical treatment.

Abstract:

The question of nitrogen removal has been discussed in Sweden; the methods that attracted the most attention are biological nitrification-denitrification and ammonia stripping.

According to the experimental results, the adverse temperature effect, except for chlorination, is most marked for ammonia stripping. Because heating and humidifying the air are expensive, it seems that ammonia stripping will not be considered as a practical method for nitrogen removal in Sweden. Hence, the most promising method at present is biological nitrification-denitrification. The conclusions drawn from the pilot plant operation with this method are summarized.

Esvelt, L.A., W.J. Kaufman, and R.E. Selleck.

Toxicity Assessment of Treated Municipal Wastewaters.

JWPCF. 45(7):1558-1572. July 1973.

Key Words: activated sludge, trickling filters, chemical treatment, chlorination.

Abstract:
The principal objectives of this study were to determine the effectiveness of toxicity removal from municipal wastewaters by conventional and advanced waste treatment processes and to identify the toxic constituents or to correlate toxicity with various measurable constituents characterizing the wastes. Several of the more significant conclusions are summarized as follows:

1. For assurance of compliance with toxicity discharge requirements within a region, it is desirable to specify standardized fish bioassay procedures in greater detail than is currently done in "Standard Methods." For example, it is preferable to employ larger numbers of a commercially available test fish giving established and consistent test responses. The continuous-flow, on-line bioassay method is useful for effluent monitoring, especially when a volatile toxicant may be present or if waste storage may cause changes in toxicity. However, the static assay technique provides similar results, is less costly, and should be acceptable in many instances.

2. Toxicity concentrations of less than 1 TU, which result when greater than 50 percent fish survival occurs in 100 percent effluent, can be estimated from fish mortality data and the mortality response-toxicity relationship obtained during this study.

Evaluation of Land Application Systems: Evaluation Checklist and Supporting Commentary.

EPA-430/9-75-001, U.S. Environmental Protection Agency, Washington D.C., Office of Water Program Operations, March 1975. 182p. (Available from National Technical Information Service (NTIS) as PB-257 440).

Key Words: agriculture, sanitary landfill, land reclamation.

Abstract:

Procedures are set forth to assist EPA personnel in evaluating treatment systems that employ land application of municipal wastewater. In addition, information and assistance is provided which may be of value to other federal, state, and local agencies, the wastewater industry, consultants and designers.

Evaluation of Municipal Sewage Treatment Alternatives.

Battelle Pacific Laboratories, Richland, Washington, February 1974. 428p. (Available from National Technical Information Service (NTIS) as PB-233 489).

Key Words: ponding/land application, chemical treatment, aerated lagoons, activated sludge, trickling filters, land reclamation, incineration, sanitary landfill.

Abstract:
This is a general discussion of alternatives in the treatment of municipal wastewater.

Evans, F.L. III.

Ozone Technology: Current Status.

In: Ozone in Water and Wastewater Treatment. F.L. Evans, ed.
Ann Arbor Science Publishers, Ann Arbor, Michigan, 1972.
pp. 1-13.

Key Words: ozonation.

Abstract:

This is briefly where ozone now stands as it has been and is being applied in water and wastewater treatment. Continuing laboratory and pilot plant studies will determine the treatability of waste streams from domestic, municipal, and industrial sources. While much has been accomplished in the past, the full potential has yet to be developed. The task in doing this will not be easy because, aside from mere demonstration of treatment comparability or superiority on a technical scale, an image tarnished by misconception must be reestablished in proper perspective. Ozonation technology has not been dormant; and prior experiences with antiquated hardware, frequent breakdowns, and faulty and dangerous operation are just that -- experiences of the past.

Contemporary ozonation hardware is the result of not only the modernization of conventional designs but also advanced conceptual design. New equipment makes use of modern high-temperature and acid-resistant materials, which have, in some instances, eliminated the necessity of incorporating the power- and space-consuming demands of some air-pretreatment and cooling-water devices. Advances in electronic design have provided new circuitry that offers advantages in power utilization and, of course, favorably affects production and therefore operating costs.

The realization of full benefits from ozone treatment will be attained through the cooperation of those advancing the science by scientific investigation, and those advancing the operational science. This cross-culturing could serve as a catalyst in making great strides to protect and improve the quality of life.

Evans, F.L. III, E.E. Geldreich, S.R. Weibel, and G.G. Robeck.

Treatment of Urban Stormwater Runoff.

JWPCF. 40(5):R162-R170. May 1968.

Key Words: salmonella, coliforms, bacteria, chlorination, combined municipal and/or stormwater systems.

Abstract:

The laboratory-scale treatment experiments with nine storm-sewer runoffs indicate the following:

1. Fecal organisms in varying densities were found in stormwater runoff. This implied health risk is substantiated further by the recovery of *Salmonella thompson* from one highly contaminated sample.

2. Less than one hour of plain settling was not helpful in reducing COD, BOD, nitrogen, phosphates, solids, or the densities of the three bacterial indicator systems.

3. Two to 6 mg/l of chlorine applied for 20 min were necessary to effect a 99.99 percent kill of the total coliforms, fecal coliforms, and fecal streptococci.

4. Despite high chlorine doses and the presence of free residual chlorine at 20-min contact, an aftergrowth of total coliforms occurred in 24 to 72 hr. There was no significant aftergrowth of the fecal coliforms or fecal streptococci.

5. The results of these studies emphasize the importance of fecal coliforms, rather than total coliforms, as a more realistic indicator of pollution.

Evans, J.O.

Soils as Sludge Assimilators.

Compost Science. 14(6):16-21. November-December 1973.

Key Words: ammonia, phosphates, zinc, boron, germanium, aluminum, manganese, cadmium, copper, nickel, lead, land reclamation.

Abstract:
This paper discusses general soil-pollutant interactions as well as giving data for various sludge types.

Evans, S.

Nitrate Removal by Ion Exchange.

JWPCF. 45(1):632-636. April 1973.

Key Words: nitrates, adsorption/ion exchange.

Abstract:

The strong acid/weak base ion exchange process is well suited to the removal of nitrates. There was virtually no leakage of nitrate ion during the demineralization cycle and the subsequent softening cycle. This unusual selectivity for nitrate ion, coupled with the use of inexpensive regenerants such as lime, make the strong acid/weak base ion exchange system particularly attractive for use in wastewater treatment. The preliminary cost estimate for water containing 14.5 me/l TDS with 70 mg/l NO_3^- is in the range of \$0.10/1,000 gal (\$3.60/cu m). Because the TDS of the water studied is high with respect to waters that usually contain nitrates, application in practice should be more economical. Only those costs related to the amount of regenerants needed are directly proportional to the TDS. For example, with a water containing about 7 me/l TDS the costs associated with lime and HCl are halved. The capital costs would be diminished to the extent that less resin is required and, therefore, tanks of smaller volume may be used.

The product water differs from that obtainable by a softening process (for example, passing raw water through a column of strong base resin in the chloride form) in that the final TDS is lower, can be adjusted by blending, and will not contain undesirable cations.

While the analysis presented did not deal with the problem of brine disposal, the importance of considering the water balance is recognized. In addition to the product water output of 0.53 mgd (2,000 cu m/day), there is a waste output of (a) 0.024 mgd (90 cu m/day) of 20,000 mg/l (expressed as mg/l $CaCO_3$) for the process of demineralization and blending, and (b) 0.016 mgd (60 cu m/day) of 20,000 mg/l (expressed as mg/l $CaCO_3$) for the process of demineralization, softening, and blending. The wastewater salinity takes into account what is regenerated from the resin, the excess HCl used, and the excess of lime solution. The wastewater volume includes the contributions from the regenerants as well as from the rinse requirements.

Ewing, B.B. and R.I. Dick.

Disposal of Sludge on Land.

In: Water Quality Improvement by Physical and Chemical Processes. E.F. Gloyna and W.W. Eckenfelder, eds. University of Texas Press, Austin, 1970. pp. 394-408.

Key Words: bacteria, viruses, *Escherichia coli*, BOD, COD, land reclamation.

Abstract:

This paper is a good review of sludge disposal to land. Included are data on contaminant concentration of digested sludge.

Falk, L.L.

Bacterial Contamination of Tomatoes Grown in Polluted Soil.

American Journal of Public Health. 89:1338-1342. October 1949.

Key Words: coliforms, bacteria, groundwater, crops.

Abstract:

The results obtained on the concentration of coliform bacteria on the surfaces of tomatoes grown in polluted soil indicated no abnormal gross contamination. Even when crops were sprayed with fecal suspensions, surface coliform counts were no greater after one month than on control tomatoes. The failure to find *Salmonella cerro* 7 days after its application to growing tomatoes upholds the contention that organisms of fecal origin will not be present in sufficient numbers to cause gross contamination.

On the basis of these results it is felt that the growth of tomatoes on soil that had received nightsoil or sewage sludge fertilization would yield crops which, if eaten raw, would not be likely vectors for the transmission of human bacterial enteric diseases.

Fannin, K.F., J.J. Gannon, K.W. Cochran, and J.C. Spendlove.

Field Studies on Coliphages and Coliforms as Indicators of Airborne Animal Viral Contamination from Wastewater Treatment Facilities.

Water Research. 11(2): 181-188. 1977.

Key Words: viruses, bacteria, activated sludge, trickling filters, air.

Abstract:

The occurrence of animal viruses in the aerosol emissions of wastewater treatment facilities was evaluated by direct assay, and by the use of coliforms and coliphages as indicator organisms. Coliforms and coliphages were compared and evaluated with regard to their suitability as indicators of airborne animal viral contamination. Ratios of coliphages to animal viruses indicate that wastewater treatment plants may be continuous sources of low-level concentrations of animal virus aerosol. Evidence shows coliforms to be much less stable than coliphages in the airborne state. Coliphages may be a more acceptable indicator of airborne animal viral contamination than coliforms.

Farrell, J.B.

Overview of Sludge Handling and Disposal.

In: Municipal Sludge Management, Proceedings of the National Conference on Municipal Sludge Management, 1974. pp. 5-10.

Key Words: cadmium, zinc, copper, nickel, mercury, coliforms, salmonella, dieldrin, DDT, chlorinated hydrocarbons, land reclamation, sanitary landfill, incineration.

Abstract:

This paper is a general discussion of final disposal methods. Passing note is made on the effect of the methods on the contaminants.

Farrington, J.W. and J.G. Quinn.

Petroleum Hydrocarbons and Fatty Acids in Wastewater Effluents.

JWPCF. 45(4):704-712. April 1973.

Key Words: synthetic/organics, surface water (marine), shellfish, influent characteristics.

Abstract:

Analyses of the concentration and composition of fatty acids in effluents agree with previously recorded data.

The results of the analyses of hydrocarbons in the effluents sampled confirm that appreciable quantities of petroleum hydrocarbons are being discharged to coastal waters by wastewater effluents. Approximately 8 bil gal (30 bil l) of municipal wastes are discharged to the coastal waters of the U.S. each day. If the concentrations of hydrocarbons in these effluents are similar to those of the Field's Point effluent, then 28,000 to 140,000 metric tons of oil are discharged each year to U.S. coastal waters by wastewater effluents. Treatment plants servicing small towns and cities may have lower concentrations of petroleum hydrocarbons, as for example, the West Warwick effluent that was sampled. On the other hand, treatment plants servicing large cities and plants providing only primary treatment probably have higher concentrations of petroleum hydrocarbons.

From available data it can be calculated that 28,000 metric tons of oil were spilled into U.S. coastal waters during 1970. The estimated amount of oil discharged by wastewater effluents is thus about the same as the reported amount of oil spilled in coastal areas. The amounts of oil entering U.S. coastal waters from numerous small spills and from oil pollution at sea (for example, ballast tank flushing) are unknown and could be equal to or greater than large spill and wastewater inputs of oil.

There is the obvious difference that oil spills are acute inputs that have acute and chronic effects. The discharge of petroleum hydrocarbons by wastewater effluents is a chronic input. Little is known about the effect of these discharges or the ability of coastal ecosystems to degrade these inputs. The authors have surveyed the sediments and clams from Narragansett Bay (R.I.) and have suggested that there is strong evidence of chronic oil pollution from small spills and from the wastewater effluents the authors sampled at Field's Point and East Providence.

Recycling of used oils, although apparently feasible, has been declining while the use of petroleum has increased. There is the danger of increasing oil discharges to the coastal waters through treated and untreated municipal wastewater and storm sewers. The amounts, types, fate, and effect of these chronic oil inputs to coastal waters should be assessed, and the technology and administrative procedures to reduce these inputs should be developed.

Fate of Organic Pesticides in the Aquatic Environment.

Advances in Chemistry Series No. 111. American Chemical Society, Washington, D.C., 1972.

Key Words: DDT, DDD, DDE, aldrin, dieldrin, endrin, chlorinated hydrocarbons, surface water (fresh), surface water (marine).

Abstract:

This is a textbook on aquatic chemistry of pesticides.

Feinstone, S.M., A. Z. Kapikian, and R.H. Purcell.

Hepatitis A: Detection by Immune Electron Microscopy of a Viruslike Antigen Associated with Acute Illness.

Science. 182:1026-1028. December 7, 1973.

Key Word: epidemiology.

Abstract:

Spherical 27-nanometer particles were visualized in stools obtained from hepatitis A patients in the acute phase of the disease. The particle was serologically specific for this disease, and every hepatitis A patient tested demonstrated a serologic response to this antigen. The findings suggest that it is an etiologic agent of hepatitis A.

Felter, R.A., S.F. Kennedy, R.R. Colwell, and G.B. Chapman.

Intracytoplasmic Membrane Structures in *Vibrio marinus*.

Journal of Bacteriology. 102(2):552-560. May 1970.

Key Words: biological contaminants, surface water (marine).

Abstract:

An electron microscope study of *Vibrio marinus* strains MP-1, an obligate psychrophile, and PS-207, a moderate psychrophile, revealed numerous intracellular membranous structures. The structures were found to occur more frequently in *V. marinus* strain MP-1 than in strain PS-207. The frequency of occurrence and complexity of structure were related to age of the culture. In early logarithmic phase, cells revealed invaginations of the plasma membrane. More complex membrane forms, found in late logarithmic and stationary phase, were either myelin-like sheaths, for which the term "myelemma" is proposed, or membranes randomly arranged throughout the cells. The complex membrane forms were not observed to be directly connected with the plasma membrane. However, they were often found in approximation to the plasma membrane or associated with vacuoles and circular membrane profiles. Individual membranes were of a tripartite structure and of dimensions similar to the cell wall and plasma membrane.

Ferens, M.C.

A Review of the Physiological Impact of Mercurials.

EPA-660/3-73-022, Savannah River Ecology Laboratory, Aiken, South Carolina, February 1974. 62p. (Available from National Technical Information Service (NTIS) as PB-234 644).

Key Words: epidemiology, mercury.

Abstract:

Studies of mercurial poisoning show that gross symptoms can be related to tissue damage. In turn, investigations of cellular changes reveal that tissue damage results from the morphological changes occurring in cells. The changes at the cellular level are more subtle in the early stages of damage, and early changes precede evidence of tissue damage. Thus, cellular changes provide a more subtle index of damage due to mercurial exposure. Relating morphological changes at the levels of the organism, tissue, and cell to biochemical effects is more difficult. Caution is stressed in trying to understand mercurial poisoning in terms of biochemical damage. The cell membrane, non-enzymatic cellular protein, and outer cell layers provide protection to the inner cells or organs. Nevertheless, researchers have theorized on probable biochemical effects which lead to the more apparent symptoms of mercurialism. Damage to Krebs' cycle enzymes and thus to the energy obtaining mechanism of the kidney, severely limits the kidney's ability to actively resorb ions. In addition, possible damage to both protein synthesis and Krebs' cycle enzymes in the brain could result in the extensive tissue damage observed in alkyl mercurial poisoning. Thus, biochemical changes can be related to other levels of organization and ultimately to the organism as the basis of the morphological and behavioral changes which characterize mercurialism.

Ferguson, J. and B. Bubela.

The Concentration of Cu(II), Pb(II), and Zn(II) from Aqueous Solution by Particulate Algal Matter.

Chemical Geology. 13:163-186. July 1974.

Key Words: copper, lead, zinc, surface water (marine).

Abstract:

Experimental studies of the reactions of Cu(II), Pb(II), and Zn(II) in aqueous solutions with organic matter derived from fresh samples of the green filamentous algae *Ulothrix* spp. and the green unicellular algae *Chlamydomonas* spp. and *Chlorella vulgaris* show that, under suitable conditions, a significant proportion of the metals is removed from solution by sorption onto the particulate organic matter of the algal suspension.

The metal sorption is strongly suppressed by H^+ but is only marginally influenced by the proportion of whole cells in the suspension and by complexing of metals in solution by the soluble organic matter. The presence of relatively small amounts of the cations Na^+ and Mg^{2+} in solution reduces the sorption of Zn(II) to near zero, but Pb(II) and Cu(II) sorption occurs to an appreciable extent even in strong brines. This may be a means for the selective precipitation of Pb(II) from brines rich in Pb(II) and Zn(II).

Metal "saturation" values indicate that particulate algal matter of the type used in these experiments could sorb sufficient quantities of metal to form an ore deposit if a weight of organic matter of similar order of magnitude to that of the inorganic sediments in the deposits was available. However, the metal sorption is an equilibrium reaction, and could be approached only in solutions whose metal contents were initially at least two orders of magnitude above those of normal seawater.

Ferguson, J.F. and M.A. Anderson.

Chemical Forms of Arsenic in Water Supplies and Their Removal.

In: Chemistry of Water Supply, Treatment, and Distribution. A.J. Rubin, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1975. pp. 137-158.

Key Words: arsenic, drinking and recreational water.

Abstract:

It was found that arsenic species may be adsorbed in large quantities onto the surfaces of amorphous ferric and aluminum hydroxides. The adsorption varies greatly with the oxidation state of the arsenic, but not with the pH within the range of 5.5 to 7.5. This adsorption evidently does not account for the high removals that are sometimes found in arsenic removal studies. The adsorption of arsenic species has posed many interesting questions. These relate first to understanding interactions between anions or neutral molecules and hydroxide surfaces. It is not clear, for instance, whether arsenate adsorption can be explained solely in terms of the molecule-surface interaction or whether the charge, concentration, and identity of the cation must also be considered. Also, the question remains as to why the same initial removal of both As(III) and (V) is found on FeOOH(s), and why saturation is not observed with As(III). At the highest surface excesses, on the order of mmol/g, the cation to arsenic ratio is between 10 and 2. At these values, can there be a useful conceptual distinction between adsorption, occlusion, and precipitation for removal onto an amorphous solid?

A second set of questions concerning the mechanism of arsenic removal in water treatment arises. Does the surface area or the nature of the surface change enough during precipitation so that adsorption, or occlusion, may be the removal mechanism in contradiction to the present results with aged precipitates? What is the role of precipitation of arsenic solids in removal? To what extent can removal be maximized by controlling mixing and flocculation in a precipitation process?

A final set of issues is related to the speciation of arsenic in water sources. The concentrations of arsenite and arsenate can now be measured at environmental levels, and information about the cycling of arsenic species is rapidly accumulating. These advances can be utilized in routine measurement of arsenic species and the establishment of separate standards for arsenic (III) and (V).

Relaxation of standards for arsenic (V) may allow use, without removal processing, of many of the surface waters that now equal or exceed the recommended limiting concentration of the U.S.P.H.S. Drinking Water Standards. In other cases, water sources that present a true hazard can be identified with certainty.

The relative abundance in the past of uncontaminated water sources near metropolitan areas no longer exists. Present understanding of arsenic removal mechanisms is still not advanced; however, studies to date indicate that removal processing seems to be approaching technological feasibility. Perhaps it is now reasonable to rely on processing to remove arsenic. In any case, the high levels of arsenic in surface waters and the demand for increased quantities of water for municipal supply indicate that careful consideration of standards and policies with respect to treatment is in order.

Ferguson, J.F. and J. Gavis.

A Review of the Arsenic Cycle in Natural Waters.

Water Research. 6:1259-1274. 1972.

Key Words: arsenic, surface water (fresh), fish, shellfish.

Abstract:

A review of the occurrence and cycling of arsenic in fresh waters is presented. The fate of arsenic in natural waters has received little attention in past years, in spite of the fact that arsenic is toxic and may be carcinogenic through exposure by drinking water.

The chemistry of arsenic in aqueous systems is reviewed. Thermodynamic information is summarized in an Eh-pH diagram for a system including sulfur. Mechanisms for removal of arsenic from the solution phase to the sediments are discussed. The possible microbially-mediated reactions of arsenic, including oxidation of arsenite, methylation of arsenic species, and reduction of arsenate, are discussed with reference to the locale of the reaction in the water column or in the sediments and to the toxicological significance of the reaction products and the rates of reaction.

A cycle of reactions for arsenic in a stratified lake is proposed and evidence is summarized relating to the occurrence and importance of particular reactions.

The potential pollution hazard of arsenic is from ingestion of drinking water with high concentrations of arsenic, rather than consuming arsenic-containing aquatic organisms. Although arsenic is greatly concentrated in aquatic organisms, it is evidently not progressively concentrated along a food chain. In addition, arsenic when consumed as an organically-bound species in flesh evidently has low toxicity.

The global cycle of arsenic is discussed. While volcanic activity is the original source of much of the arsenic in sedimentary rocks, in recent times weathering of arsenic has been approximately in balance with deposition of arsenic in sediments. Human activities, including the use of arsenic, the burning of fossil fuels, increased erosion of land and the mining and processing of sulfide minerals, have increased the amount of arsenic entering the oceans by at least a factor of 3. This increase will have no effect on the concentration in the oceans for many hundreds of years.

However, these cultural contributions are the source of high localized concentrations in many fresh waters. Careful surveillance and increased knowledge of the fate of arsenic in the aquatic environment are needed to insure that there will be no public health hazard.

Ferguson, J.F., D. Jenkins, and J. Eastman.

Calcium Phosphate Precipitation at Slightly Alkaline pH Values.

JWPCF. 45(4):620-631. April 1973.

Key Words: phosphates, manganese, fluorides, chemical treatment, activated sludge.

Abstract:

Calcium phosphate precipitation at wastewater concentrations at all values near 8 was found characteristically to have an induction period followed by crystal growth. Phosphate removal during crystal growth behaved as if the precipitation reaction were limited by a reaction at the interface between solid and liquid. The effect of bicarbonate on the kinetics of phosphate removal during crystal growth can be described by an empirical rate equation in which the rate of phosphate removal is proportional to the available surface area (assumed to remain constant during precipitation), and the phosphate concentration is raised to the 2.7 power and is inversely proportional to the bicarbonate concentration.

The rate equation for the precipitation reaction was applied to predict phosphate removal for four continuous reactor types. Three reactors - a CSTR, a CSTR with solids recycle, and a tubular reactor with solids recycle - have the advantages of eliminating the induction period either by recycling precipitated solids or by backmixing.

Reactors with solids recycle have the additional advantage of increasing the concentration of solids and the surface area available for crystal growth. Predictions and limited experimental data show that calcium phosphate precipitation at pH 8 can effectively remove 80 to 95 percent of the phosphate from wastewater in a solids recycling reactor and that tubular reactors are much more effective than completely stirred reactors.

It is feasible to use the low-pH calcium phosphate precipitation process in combination with the activated sludge process if the following wastewater characteristics exist and operating design criteria are adhered to.

1. The upper limits for alkalinity and magnesium concentrations at which this process should be contemplated are, respectively, 350 mg/l as $CaCO_3$ and 24 mg/l as Mg.

2. Solids recycle from the secondary sedimentation basin should be rapid so that low pH conditions will

not develop and cause redissolution of the precipitated solids.

3. The optimum pH for the process should be between 7.5 and 8.5 and should be the highest value in this range that is compatible with bacterial growth and at which negligible calcium carbonate precipitation occurs.

The process offers considerable hope for savings in the chemical and capital costs associated with phosphate removal because of the lower doses and the possibility of utilization of existing basins by superimposition on the activated sludge process flow scheme.

Fertilizer Application Rates and Nitrate Concentrations in Illinois Surface Waters.

Illinois Institute for Environmental Control, Chicago. 1974.

Key Words: nitrates, surface water (fresh).

Abstract:
This article discusses nitrate concentrations in surface water.

Field, R. and J.A. Lager.

Countermeasures for Pollution from Overflows: the-State-of-the-Art.

EPA-670/2-74-090, Metcalf and Eddy, Inc., Palo Alto, California, December 1974. 40p. (Available from National Technical Information Service (NTIS) as PB-240 498).

Key Words: combined municipal and/or storm systems.

Abstract:

Control and/or treatment of stormwater discharges and combined sewage overflows from urban areas are problems of increasing importance in the field of water quality management. Over the past decade much research effort has been expended and a large amount of data has been generated, primarily through the actions and support of the U.S. Environmental Protection Agency's (EPA) Storm and Combined Sewer Research and Development Program. Presented in this text are selected results of a comprehensive investigation and assessment of promising, completed and ongoing projects, representative of the state-of-the-art in abatement theory and technology; a look at recent legislation; and the identification of program needs and emphasis.

Combined sewer overflows are major sources of water pollution problems, but even discharges of stormwater alone can seriously affect water quality. Current approaches involve control of overflows, treatment, and combinations of the two. Control may involve maximizing treatment with existing facilities, control of infiltration and extraneous inflows, surface sanitation and management, as well as flow regulation and storage. A number of treatment methods have been evaluated including high rate screening and microstraining, ultra high rate filtration, dissolved air flotation, physical/chemical treatment, and modified biological processes. A swirl flow regulator/solids separator of anular shape construction with no moving parts has been developed. High rate disinfection methods including new disinfectants have been applied.

Promising approaches involve integrated use of controls and treatment. The most disappointing have generally lacked flexibility in their operation and design. Mathematical models have been developed and successfully applied at multiple levels of sophistication and complexity.

Filmer, R.W., M.Felton, Jr., and T. Yamamoto.

Virus-Sized Particle Adsorption on Soil - Part I: Rate of Adsorption.

In: Proceedings of the Thirteenth Water Quality Conference: Virus and Water Quality: Occurrence and Control, University of Illinois, February 1971. pp. 75-101.

Key Words: viruses, adsorption/ion exchange.

Abstract:

1. Under the conditions of this investigation, the primary mechanism controlling the rate of adsorption of albumin on silica was a diffusion process.

2. The theoretical analysis based on diffusion-adsorption models was developed and agreed with experimental data fairly well.

3. The theoretical model tells that the type of adsorption isotherm is not critical to the rate of adsorption.

4. Theory predicts that the rate of adsorption is proportional to the square of the specific surface, the square of the concentration of soil, and the diffusivity of albumin molecules.

Finberg, L.

Interaction of the Chemical Environment with the Infant and Young Child.

Pediatrics. 53:831-837. 1974.

Key Word: epidemiology.

Abstract:

Architecture, commerce, hygiene, recreation, and education contribute to the child's physiochemical milieu. The article discusses home, school, and hospital hazards, commercial hazards, hazards of hygiene, dangerous toys, special susceptibility of the child, delayed effects, hexachlorophene, lead, air pollution, and asthmas.

Fink, W.B., Jr. and D.B. Aulenbach.

Protracted Recharge of Treated Sewage into Sand. Part II: Tracing the Flow of Contaminated Ground Water with a Resistivity Survey.

Ground Water. 12(4):219-223. July-August 1974.

Key Words: suspended solids, groundwater.

Abstract:

To aid in determining the direction of groundwater flow after the effluent from the Lake George Village sewage treatment plant is discharged onto natural delta sand beds, resistivity studies were made in the soil (sand) in the vicinity of the recharge beds. Groundwater having high dissolved solids is identified as producing lower resistivity readings. The sewage effluent has a higher dissolved solids content than the existing groundwater in the area. The path of the recharged sewage effluent, as identified by lower resistivity readings, appears to flow in a northerly direction from the sewage treatment plant along Gage Road toward West Brook. Due to interferences, the resistivity studies could not show whether the high conductivity groundwater flows into or under West Brook.

Finkel, A.J. and W.C. Duel, eds.

Clinical Implications of Air Pollution Research.

Presented at the American Medical Association Air Pollution Research Conference, December 1974.

Key Word: epidemiology.

Abstract:

An excellent reference on effects of air pollution on health:

- respiratory diseases,
- cardiovascular diseases,
- immunology, hypersensitivity, and host defense,
- central nervous system and sense organs,
- illness of children.

Fitzgerald, P.R. and W.R. Jolley.

The Use of Sewage Sludge in Pasture Reclamation: Parasitology, Nutrition and the Occurrence of Metals and Polychlorinated Biphenyls.

University of Illinois - Urbana, 1974.

Key Words: chlorinated hydrocarbons, protozoa, parasitic worms, cadmium, chromium, copper, manganese, mercury, nickel, lead, zinc, agricultural sludge disposal, crops.

Abstract:

The effect of sludge application to pasture from August 1, 1973 through September 30, 1974 is reported. Bovine parasitology, the occurrence of heavy metals and polychlorinated biphenyls in soil and cattle field, and the nutritional quality of feeds were the aspects examined both in sludge-amended and control pastures. Monthly pasture soil samples were examined for cadmium, chromium, copper, manganese, mercury, nickel, lead and zinc to determine whether or not sludge application caused an accumulation in the soil of any of the metals. The levels of the metals tested were not appreciably greater in the test pastures than in the controls, and no accumulation of the metals could be correlated with pasture sludge applications. Continued analysis of the basic units of the production system, i.e., soil, feed, and animals, for a period of at least five years would be necessary to adequately predict the hazards or safety of using sludge in such a system.

Flinn, J.E. and R.S. Reimers.

Development of Predictions of Future Pollution Problems.

EPA-600/5-74-005, Battelle-Columbus Laboratories, Columbus, Ohio, March 1974. 222p. (Available from National Technical Information Service (NTIS) as PB-233 117).

Key Words: cadmium, manganese, lead, mercury, zinc, copper, barium, boron, arsenic, nickel, selenium, beryllium, COD, phosphates, total dissolved solids, coliforms, bacteria, chlorinated hydrocarbons, organophosphorous pesticides, pesticides, antibiotics, ammonia, surface water (fresh).

Abstract:

The report describes the results of a program to identify, rank and project short- and intermediate-term future pollution problems.

Identification was accomplished using three independent search approaches based on industrial production, environment and societal trends and activity. Primary emphasis was placed on the environmental trends as gleaned from EPA, Battelle, literature, and other sources. An initial list of problems was compiled with specific stressors identified with each.

Nine ranking factors were devised to select ten "most serious" problems from the initial list. The factors included: persistence; mobility/pervasiveness; environmental, technological, social, and political complexity; physiological risk; research needs, and bulk or volume of the pollutant. The ten problems selected by this method were further ranked in order of relative importance. The ten selected problems in rank order are as follows:

Impacts of New Energy Initiatives
Geophysical Modifications of the Earth
Trace Element (Metal) Contaminants
Proliferating Hazardous and Toxic Chemicals
Emissions from New Automobile Fuels, Additive, and Control Devices
Disposal of Waste Sludges, Liquids, and Solid Residues
Critical Radiation Problems
Fine Particulates
Expanding Drinking Water Contamination
Irrigation (Impoundment) Practices.

Five to ten year projections were made of the ten problems which resulted.

Flinn, J.E., T.J. Thomas, and M.D. Bishop.

Identification Systems for Selecting Chemicals or Chemical Classes as Candidates for Evaluation.

EPA-560/1-74-001, Battelle-Columbus Laboratories, Columbus, Ohio, November 1974. 153p. (Available from National Technical Information Service (NTIS) as PB-238 196).

Key Words: heavy metals, copper, zinc, lead, cadmium, mercury, chromium, synthetic/organics, pesticides, DDT, DDD, DDE, aldrin, dieldrin, endrin, chlorinated hydrocarbons.

Abstract:

This report summarizes the state-of-the-art on systems, either existing or conceptual, that can be used or adapted for use to select, assess, and prioritize chemicals for their health or environmental effects. It is found that, while numerous systems can be identified, none have been formulated with sufficient breadth to permit accomplishing all the functions desired by EPA's Office of Toxic Substances. These functions include:

(1) Identification of chemical hazards to man and his environment
(2) Selecting chemicals not already in use
(3) Assessing potentially hazardous degradation products or synergistic effects
(4) Assessing hazards to plants, animals, and the non-living environment.

Effective combinations of limited scope systems have been assembled by Federal agencies to achieve the chemical identification/assessment/prioritization functions needed for such public concerns as the work-place environment; human health (cancer, child poisoning, birth defects); air, water, and land contamination; and consumer-product hazards. Examination of the operational basis of a number of the individual systems within these combinations suggests that all are variations of a relatively few number of approaches to chemical selection.

Focht, D.D.

Microbial Degradation of DDT Metabolites to Carbon Dioxide, Water, and Chloride.

Bulletin of Environmental Contamination and Toxicology. _7_(1):52-56. January 1972.

Key Words: DDT, surface water (fresh), surface water (marine).

Abstract:

Fungus is capable of converting chlorinated hydrocarbons to H_2O, CO_2, and HCl.

Foehrenbach, J.

Chlorinated Pesticides in Estuarine Organisms.

JWPCF. 44(4):619-624. April 1972.

Key Words: DDT, DDD, DDE, dieldrin, fish, shellfish.

Abstract:

1. Of the chlorinated hydrocarbons analyzed for, only DDT, DDD, DDE, and dieldrin were found.

2. The residues found in shellfish are well below the limits set by the Food and Drug Administration.

3. The residues found were in such concentrations that they should not have any adverse short-term effects on organisms low in the food chain.

4. Organisms at the higher trophic levels of food chains have larger concentrations of pesticides than those at the lower levels. Because of this, the organisms at the top of a food chain may be adversely affected.

5. Because very little is known about the long-term effect of low residue concentrations, all synthetic chemicals should be used only with extreme caution in the natural environment.

Foehrenbach, J., G. Mahmood, and D. Sullivan.

Chlorinated Hydrocarbon Residues in Shellfish (Pelecypoda) from Estuaries of Long Island, New York.

Pesticides Monitoring Journal. 5(3):242-247. December 1971.

Key Words: DDT, DDD, DDE, dieldrin, shellfish.

Abstract:

Since October 1968, shellfish from 10 estuaries in Long Island, N.Y., have been collected on a monthly basis and examined for chlorinated hydrocarbons. This study covers the period up to July 1970. The residues found were DDT, DDD, DDE, and dieldrin: concentrations were low, the highest being 0.146 mg/kg, wet weight. The distribution of residues could at times be correlated with agricultural use or type of community in the watershed surrounding the various stations.

Folk, G.

Phosphorus Removal with Liquid Alum.

WPCF Highlights. pp. 8-9. February 1976.

Key Words: phosphates, chemical treatment.

Abstract:

Phosphorus removal efficiencies in a wastewater treatment plant were compared using several different chemical additives. A problem with using liquid alum is the increased amount of sludge which is generated.

Folkman, Y. and A.M. Wachs.

Filtration of Chlorella through Dune-Sand.

Journal of the Sanitary Engineering Division, ASCE.
96(SA3):675-689. June 1970.

Key Words: Vibrio cholerae, filtration.

Abstract:

In order to study processes occurring when effluents of stabilization ponds are used in artificial groundwater recharge, algae filtration experiments were conducted using a long column filled with dune sand.

Under conditions of darkness, such as those prevailing in the experimental setup, chlorella cells divide into smaller dark cells, and their size distribution range becomes narrower. Consequently, the efficiency of filtration is decreased.

For all filtration velocities used in the work reported herein, ranging from 1 m per day to 6 m per day, the retention of algae occurred mostly at the upper part of the sand column, where the increments of head losses were observed. The hydraulic gradient remained practically constant in the rest of the column.

Results of the algae filtration experiments showed that changes of the relative concentration of algae as a function of depth closely corresponded with a filtration equation proposed by Ives, when a coefficient B was introduced to account for algae multiplication.

In comparison with river bank sand generally used as a filter medium, dune sand, being of maritime origin, contains a much higher proportion of calcium carbonate. As a consequence of algae respiration CO_2 is evolved, which transforms the calcium into soluble bicarbonate. This changes the characterization of the medium and increases the hardness of the percolating water.

The effect of cation concentration in the water on the efficiency of filtration was clearly shown. The addition of cations to filtrating water produced significant increases in that efficiency.

Results of the experiments showed that when lower velocities were used, larger quantities of water could be filtered and the filtration efficiency was better. With other conditions equal, higher filtration was obtained with lower initial concentrations of the suspension.

Foodborne and Waterborne Disease Outbreaks Annual Summary 1973.

U.S. Center for Disease Control, HEW. 1974.

Key Word: epidemiology.

Abstract:
This report summarizes information about foodborne and waterborne disease outbreaks in 1973.

Foodborne and Waterborne Disease Outbreaks Annual Summary 1975.

U.S. Center for Disease Control, HEW. September 1976.

Key Word: epidemiology.

Abstract:
This report summarizes information about foodborne and waterborne disease outbreaks in 1975.

Fossum, G.O.

Water Balance in Sewage Stabilization Lagoons.

North Dakota University, Grand Forks, Civil Engineering Department, August 1971. 38p. (Available from National Technical Information Service (NTIS) as PB-233 482).

Key Words: suspended solids, fluorides, phosphates, chlorides, ponding/land application.

Abstract:

Site selections and construction details have often ignored seepage beyond the requirements that the lagoon bottom should be a relatively impervious material, such as clay, and no seepage into wells or groundwater supplies should be permitted. Enforcement of Water Quality Standards makes it necessary to retain high water levels in sewage lagoons for longer periods of time than has been done in the past. There have been complaints from adjacent land owners that lagoon seepage was damaging crop land, and damage claims have been filed through legal channels.

This paper proposes a value of the coefficient, N, of .000271 in the mass-transfer equation. Use of this coefficient, the wind speed, and the humidity gradient permits calculation of evaporation. Also proposed is a seepage rate of .0032 feet per day which permits determination of seepage loss. Limitations on their usage are discussed.

Evidence is presented showing definite effects on groundwater tables for distances of approximately 400 feet. Conditions which create serious damage to productivity of adjacent land for distances of 300 feet or more are discussed. Effects on groundwater quality as indicated by total solids, chlorides, sulfates, phosphates and fluorides are presented and related to natural and artificial topographic features.

Foster, D.H. and R.S. Engelbrecht.

Microbial Hazards in Disposing of Wastewater on Soil.

In: Conference on Recycling Treated Municipal Wastewater through Forest and Cropland. W.E. Sopper and L.T. Kardos, eds. EPA-660/2-74-003, Pennsylvania State University, University Park, Institute for Research on Land and Water Resources, March 1974. pp. 217-241.

Key Words: salmonella, shigella, mycobacterium, protozoa, parasitic worms, virus, Escherichia coli, influent characteristics, gravity separators, activated sludge, trickling filter, anaerobic digestion, chlorination, ponding/land applications.

Abstract:

This paper provides an excellent background for biological pathogens in soil disposal considerations. It also discusses pathogen occurrence in wastewater. In addition, the bibliography may be useful for further information.

Frank, R., A.E. Armstrong, R.G. Boelens, H.E. Braun, and C.W. Douglas.

Organochlorine Insecticide Residues in Sediment and Fish Tissues, Ontario, Canada.

Pesticides Monitoring Journal. 7:165-180. March 1974.

Key Words: DDT, DDD, DDE, dieldrin, surface water (fresh), fish.

Abstract:

River and lake sediments and several species of fish were collected from four study areas in the Province of Ontario. These consisted of one agricultural, two mixed agricultural-recreational, and one recreational study area. Large volumes of DDT and dieldrin were used in the first area, small quantities were used in the mixed areas, and insignificant quantities were used in the recreational area. The agricultural and mixed areas were located on deep alluvial soils; the recreational area was located on bare-to-thinly-covered Precambrian rock. Residue levels in sediments were similar in all four areas, but slightly higher in the recreational area. The ratios of DDT to its metabolites, DDE and TDE, were similar in all areas in that the metabolites predominated over the parent DDT. Residues of DDT and dieldrin in fish tissues tended to depend on feeding habits, fat content, and age of the fish. Residues in the sediment (dry weight) were almost the same as residues found in the low-fat benthic invertebrate and plankton feeders.

Residues increased in the low-fat piscivores, were slightly higher in the high-fat feeders, and were highest in the high-fat piscivores. The concentration of DDT and dieldrin in the tissues and extractable fat and the actual quantity accumulated per fish increased as size and weight of any one species increased. The increase in total DDT or dieldrin concentration from lowest to highest tissue residues of all fish species was of the order of 100 to 500 times; the increase in body load was of the order of 10^5 to 10^6. Higher concentrations in fish tissue were correlated with the higher sediment levels of the Precambrian recreational area. Data demonstrate that the use of even minute quantities of persistent chlorinated hydrocarbons in rocky Precambrian watersheds has a profound effect on sediment and biota contaminants. Use on deep rich soils has a similar effect, but not in the same proportion to the quantity used.

Franz, M.

Developing A Safe Way to Recycle Sewage Sludge on the Land.

Compost Science. 15(1):6-7. January-February 1974.

Key Words: agricultural sludge disposal, composting.

Abstract:
This is a general discussion on agricultural disposal of sludge.

Freeman, H.C., D.A. Horne, B. McTague, and M. McMenemy.

Mercury in Some Canadian Atlantic Coast Fish and Shellfish.

Journal of the Fisheries Research Board of Canada. 31(3): 369-372.
March 1974.

Key Words: mercury, fish, shellfish.

Abstract:

All species of North Atlantic fishes studied, with the exception of two groups of off-shore lobsters, had total mercury levels less than the 0.5 ppm limit allowed for fish of commerce in Canada and the United States. There appeared to be no relationship between mercury levels. and the sex and/or weight of fish of any one species.

The first indication that mercury was a threat to public health came from the Japanese mercury poisoning epidemics in the early 1950's. This initiated many studies. Apparently increased industrial and agricultural use and the broad dissemination of mercury compounds had caused mercury contamination in fish.

Freudenthal, J. and P.A. Greve.

Polychlorinated Terphenyls in the Environment.

Bulletin of Environmental Contamination and Toxicology. 10:108-111. August 1973.

Key Words: chlorinated hydrocarbons, air, surface water (fresh), shellfish.

Abstract:
This article establishes levels of PCT in river water, oysters, eel, and human fat. Comparisons are made between PCT and PCB levels.

Friberg, L., T. Kjellstrom, G. Nordberg, and M. Piscator.

Cadmium in the Environment - III: A Toxicological and Epidemiological Appraisal.

Karolinska Institute, Stockholm, Sweden, June 1975. 218p.

Key Words: cadmium, biological contaminants, surface water (fresh), surface water (marine), livestock, groundwater.

Abstract:
This is a review of the recent biomedical literature on cadmium and its toxicological and epidemiological effects on the environment as well as on human welfare.

Fuhs, G.

A Probabilistic Model of Bathing Beach Safety.

The Science of the Total Environment. 4:165-175. 1975.

Key Words: bacteria, drinking and recreational water,
surface water (fresh).

Abstract:

An improved mathematical model for bathing beach safety is proposed. It is derived by joining the probability of infection from a given dose (Poisson distribution) and the probability of acquiring such a dose (lognormal distribution).

Even in the absence of better clinical and epidemiological data, the model permits an assessment of relative risk from certain hazards and the design of more meaningful bacteriological standards for individual beaches.

Fujiya, M.

Physiological Estimation on the Effects of Pollutants Upon Aquatic Organisms.

Advances in Water Pollution Research. 1964(3):315-331.

Key Words: COD, fish.

Abstract:

The most serious effects, such as the histopathological changes of tissues in visceral organs, necrosis and desquamation, etc., were caused by water of more than 50 mg/l in COD value, and more slight symptoms, cytochemical changes such as the decrease of RNA in pancreas and the accelerative secretion of mucous gland, etc., were caused by water more than 10 mg/l in COD value. Also, the most minor symptom observed through hematologic investigations was caused by water less than 5 mg/l in COD value.

Therefore, the physiologically effective dose of the pulp mill waste to the organisms is estimated to be the concentration of 5 to 50 mg/l in COD value. It is notable that the effective dose is quite low in comparison with the TLm value (about 400 mg/l in COD).

Fukaya, H.

Treatment of Sludges Containing Heavy Metals.

Chemical Abstracts. 82:47432a. 1975.

Key Words: zinc, chromium, incineration.

Abstract:

Wastewater sludge from Cr, Zn, or hard Cr plating processes, with or without additives such as clay and kaolin, was sintered at 800-1300° to fix heavy metals in the sintered product. The sludges, except that from the hard Cr platin process, had excellent sinterability, and this method reduced the destruction of treating containers and degradation of contained material. The addition of clay or kaolin and also sintering at higher temperatures improved the fixation of heavy metals in the sintered product.

Furgason, R.R. and R.O. Day.

Iron and Manganese Removal with Ozone. Part I.

Water and Sewage Works. 122(6):42, 45-47. June 1975.

Key Words: iron, manganese, surface water (fresh), ozonation.

Abstract:

Manganese and iron can be effectively and economically oxidized by ozone to an insoluble form that can be filtered from water.

Furgason, R.R. and R.O. Day.

Iron and Manganese Removal with Ozone. Part II.

Water and Sewage Works. 122(7):61-63. July 1975.

Key Words: iron, manganese, surface water (fresh), ozonation.

Abstract:

Manganese and iron can be effectively and economically oxidized by ozone to an insoluble form that can be filtered from water.

Furr, A.K., A.W. Lawrence, S.S.C. Tong, M.C. Grandolfo, R.A. Hofstader, C. A. Bache, W.H. Gutenmann, and D.J. Lisk.

Multielement and Chlorinated Hydrocarbon Analysis of Municipal Sewage Sludges of American Cities.

Environmental Science and Technology. 10(7):683-687. July 1976.

Key Words: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, germanium, iron, lead, manganese, mercury, molybdenum, nickel, selenium, thorium, tin, uranium, zinc, elemental contaminants, synthetic/organics, dieldrin, combined municipal and/or industrial systems.

Abstract:

An analytical survey of 68 elements, dieldrin, and polychlorinated biphenyls (PCB's) was conducted in municipal sewage sludges sampled during 1972-73 from 16 American cities using several instrumental methods. Unusually elevated concentrations of certain toxic elements were found in sludges from specific cities. Relatively high levels of gold and mercury in sludge from San Francisco possibly derived from geo-chemical sources. Fluorine was high in several cities which fluoridate their water. PCB's were highest in sludge from Schenectady.

Gaby, W.L.

Evaluation of Health Hazards Associated With Solid Waste/Sewage Mixtures.

EPA-670/2-75-023. East Tennessee State University, Johnson City, Dept. of Health Sciences, April 1975. 56p. (Available from National Technical Information Service (NTIS) as PB-241 810).

Key Words: fecal streptocci, viruses, coliforms, bacteria, salmonella, shigella, leptospirosis, protozoa, coxsackie virus, polio virus, composting.

Abstract:

The composting of refuse-sewage sludge by the windrow process results in the aerobic biodegradation of organic solids and liquids to a relatively stable end product which may be used as a soil conditioner without creating health hazards or pollution of water, land or air. Composting is a rapid and natural process by which all organic matter is decomposed by microorganisms to inorganic compounds or elements which are utilized by other plants and animals. This cyclic transformation is an essential process without which all plant and animal life would cease. Anaerobic biodegradation also occurs in such processes as landfills, but at a much slower rate. The microbial ecology of compost is directly related to the internal temperature of the windrow. These studies indicate that large numbers of microorganism present in refuse and sewage sludge utilize the nutrients available, releasing excessive energy which increases the temperature of the windrow to a maximum of approximately 167°F (74°C) within 7 days. The disappearance of inserted selected pathogenic microorganisms from compost is directly related to this temperature increase and not to any type of antagonistic action resulting from antibiotic activity or other metabolic products of microorganisms in compost. Proper processing, such as aeration and moisture is required for the windrow to reach a temperature of 120°F to 167°F (49°C to 74°C) or greater for a period of 4 to 7 days. If the windrow temperature does not reach 120°F (or falls below 120°F), the microbial flora and pathogens remain viable at a high level and may increase in numbers.

Temperatures observed in the top and bottom 2-4 in layers of the windrows were extremely variable and could not ensure the destruction of pathogens unless the windrows were properly turned.

The handling and disposal of refuse and refuse-sewage sludge should be considered a health hazard and a potential source of many microbial infections.

Gadde, R.R. and H.A. Laitinen.

Studies of Heavy Metal Adsorption of Hydrous Iron and Manganese Oxides.

Analytical Chemistry. 46:2022-2026. November 1974.

Key Words: lead, cadmium, zinc, surface water (fresh), surface water (marine).

Abstract:

Individual adsorption studies of Pb^{2+}, Cd^{2+}, and TI^{+} on hydrous iron and manganese oxides are reported. Using pulse polarography to determine the heavy metal ion concentrations before and after adsorption, their effects of hydrogen ion and metal ion concentrations on the adsorption were evaluated. For the divalent ions, the ratio, H^{+} released per heavy metal ion adsorbed was greater than one. Specific adsorption of Pb^{2+}, Zn^{2+}, and Cd^{2+} on hydrous manganese oxide (HMO) and also Pb^{2+} and Cd^{2+} on hydrous ferric oxide (HFO) was observed. Except for TI^{+} on HMO, which is complicated by a redox process, the adsorption on HFO and HMO followed the order $Pb^{2+} > Zn^{2+} > Cd^{2+} > TI^{+}$. The adsorption processes are reversible with respect to H^{+} and other absorbing ions. Adsorption capacities of the order of 0.2 mole heavy metal ion/mole HMO were observed except in the case od lead, which showed much higher adsorption (0.56 mole/mole HMO).

Gaitan, E.

Water-Borne Goitrogens and Their Role in the Etiology of Endemic Goiter.

World Review of Nutrition and Dietetics. 17:53-90. 1973.

Key Words: iodides, drinking and recreational water.

Abstract:
Endemic goiter in the Cauca Valley of Columbia is not due to dietary iodine deficiency, but it can be correlated with the source of drinking water.

Gales, M.E., Jr, and R.L. Booth.

A Copper-Cadmium Column for Manually Determining Nitrate.

News of Environmental Research in Cincinnati: Methods Development and Quality Assurance Research. February 28, 1975.

Key Words: nitrates, cadmium, copper, surface water (fresh), primary water treatment processes.

Abstract:

Because of standard methods inaccuracies in determining nitrate concentration in water, a copper-cadmium column is investigated for possible use with >95% recovery efficiency.

Gallagher, T.P. and D.F. Spino.

The Significance of Numbers of Coliform Bacteria as an Indication of Enteric Pathogens.

Water Research. 2:169-175. 1968.

Key Words: bacteria, coliforms, drinking and recreational water, salmonella.

Abstract:

To ascertain whether there is any level of total and fecal coliform densities below which the probability of isolating salmonellae, a pathogenic bacteria, would be negligible, a comparison of coliform data with salmonellae data gathered in stream surveys throughout the United States has been made. Since one of the premises for using coliform as an indicator organism is that it is presumably indicative of the probable presence of pathogenic organisms, any relationship between numbers of coliform and isolation of pathogens would be valuable in determining permissible bacteriological water quality standards. A comparison of Salmonella typhimurium and fecal coliform survival time conducted under laboratory conditions is also presented. A summary of data shows little apparent correlation between levels of total or fecal coliform and the isolation of salmonella. Some observations are made as to why this may be so, and the implications of using only coliform densities to describe bacteriological acceptability for recreational and fishing uses are discussed.

Gamble, D.S. and M. Schnitzer.

The Chemistry of Fulvic Acid and Its Reactions with Metal Ions.

In: Trace Metals and Metal-Organic Interactions in Natural Waters. P.C. Singer, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1974. pp, 265-302.

Key Words: copper, nickel, cobalt, lead, zinc, elemental contaminants, surface water (fresh), surface water (marine).

Abstract:

It must be remembered that fulvic acid is primarily a polyelectrolyte, and that it is even more a mixture than are most polymers. Since, in fact, one cannot assume that any two of the ionizable functional groups are chemically identical, it follows necessarily that an experimentally observed equilibrium function is a weighted average function. This has certain practical consequences for the study of water chemistry.

The experimentally measured equilibrium function for the reaction of fulvic acid with a cation is a variable. This variable is a function of the weighting factors of the participating functional groups, and of the electrostatic charge accumulated on the polymer molecules. Any attempt to describe such an equilibrium with a simple numerical constant is therefore a fundamental flaw in logic. This mistake may lead to wrong conclusions about the chemistry of natural waters.

Gambrell, R.P. and S.B. Weed.

The Fate of Fertilizer Nutrients as Related to Water Quality in the North Carolina Coastal Plain.

North Carolina Water Resources Research Institute, Raleigh, August 1974. 167p. (Available from National Technical Information Service (NTIS) as PB-238 001).

Key Words: nitrates, phosphates, ponding/land application.

Abstract:

Quantities of nitrogen and phosphorus moving into surface and subsurface waters from cultivated soils of the North Carolina Coastal Plain, as affected by internal drainage, were determined. In a moderately well-drained soil, little denitrification was found; in a poorly-drained soil with a high water table, much of the unutilized fertilizer nitrogen was lost from the field through denitrification. Little phosphorus was lost from either location studied except by surface movement with eroded sediments. Application of fertilizer nitrogen (224 kg/ha) resulted in an increase in loss of total nitrogen by surface runoff from both soils. Values were 29 percent for the moderately well-drained soil and 10 percent for the poorly-drained soil. Nitrogen lost in surface runoff was almost exclusively organically bound, indicating that fertilizer applications serve to maintain the level of soil organic nitrogen.

Ganczarczyk, J.

Nitrogen Transformation in Activated Sludge Treatment.

Journal of the Sanitary Engineering Division, ASCE. 98(SA5): 783. October 1972.

Key Words: ammonia, nitrates, activated sludge.

Abstract:
This paper discusses inhibiting factors in the nitrification process.

Gangoli, N. and G. Thodos.

Phosphate Adsorption Studies.

JWPCF. 45(5):842-849. May 1973.

Key Words: phosphates, adsorption/ion exchange.

Abstract:

The experimental results obtained from the different treatments associated with AHB alumina, F1 alumina, and fly ash indicated that the adsorptive capacity for phosphates was greatest when these adsorbents were used without any treatment. It should be noted that these results differ from those reported by Yee, who pointed out that activation with nitric acid brought an increase in the adsorptive capacity of F1 alumina.

F1 alumina and fly ash possessed a higher adsorptive capacity than AHB alumina. Economic considerations would dictate the final selection between F1 alumina and fly ash, and, because fly ash is available as a waste product, it seems that this substance may prove to be the most promising adsorbent for the removal of phosphates.

Ganje, T.J.

Selenium.

In: Diagnostic Criteria for Plants and Soils.
Homer D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 394-404.

Key Words: selenium, ponding/land application,
land reclamation, groundwater, crops.

Abstract:

While selenium seems to have no beneficial effect on the nutrition of cultivated crops and native grasses, stimulation of plant growth at low concentrations of selenium has been shown. The author describes plant criteria useful in diagnosing selenium excess, indicator plants for selenium content, tissue analysis values, kinds of soils and places in which selenium excess occurs, conditions which lead to selenium accumulation in soils, selenium content of soils, plant uptake experiments, and control of selenium excess.

Garber, W.F.

Bacteriological Standards for Bathing Waters.

Sewage and Industrial Wastes. 28(6):795-807. June 1956.

Key Words: bacteria, surface water (fresh), drinking and recreational water.

Abstract:

This article presents a concept of the attitude an agency operating a sewage treatment plant or other source of waste discharge might properly take toward the bacterial standards required for the receiving waters used.

Garcia, W.J., C.W. Blessin, G.E. Inglett, and R.O. Carlson.

Physical-Chemical Characteristics and Heavy Metal Content of Corn Grown on Sludge Treated Strip-Mine Soil.

Journal of Agricultural and Food Chemistry. 22(5):810-815. September-October 1974.

Key Words: zinc, manganese, copper, lead, chromium, cadmium, mercury, crops.

Abstract:

Corn crop on strip-mine soil, where anaerobically digested liquid sludge had been applied, yielded a four fold increase over untreated corn. Furthermore, protein enhancement and heavy metal concentration were also found to have increased.

Gardner, D. and J.P. Riley.

Distribution of Dissolved Mercury in the Irish Sea.

Nature. 241:526-527. February 1973.

Key Words: mercury, surface water (marine).

Abstract:

In measured concentrations of mercury in seawater near the British Isles, authors found concentrations of ~900 mg/l near area where dried sewage sludge was being dumped. The range of mercury normally was 25-50 mg/l.

Gaufin, A.R.

The Fate and Effects of Pesticides in the Aquatic Environment of the Flathead Lake Drainage Area.

Montana State University, Bozeman, Water Resources Center, January 1974. 50p. (Available from National Technical Information Service (NTIS) as PB-232 252).

Key Words: DDT, surface water (fresh), groundwater.

Abstract:

A one-year preliminary sampling of pesticide practices on the Flathead Indian Reservation was conducted, with later work concentrating on the effects of DDT on osprey survival and nesting on Flathead Lake, Montana. The first year's sampling program indicated that major surface, underground and culinary waters were contaminated with Tordon and probably other pesticides and/or herbicides. The phenomenon was believed responsible for the catastrophic decline of the populations of many predatory birds, with evidence that it might also be responsible for the decline of the Flathead Lake osprey population. The later work provided additional confirmation of the osprey population decline and delineated possible reasons.

Gavis, J.

Wastewater Reuse.

National Water Commission, Arlington, Virginia, 1971. 164p. (Available from National Technical Information Service (NTIS) as PB-201 535).

Key Words: suspended solids, ammonia, nitrates, nitrites, phosphates. antibiotics, total dissolved solids, viruses, surface water (fresh), screening operations, filtration, nitrification/denitrification, aerated lagoons, activated sludge, anaerobic lagoons, adsorption/ion exchange, chlorination.

Abstract:

The report evaluates the potential for wastewater reuse through reclamation of effluents from advanced wastewater treatment plants. Brief descriptions and references indicate the extent of such practice at the present time and likely possibilities for future developments. Emphasis is on the resource value of wastewater. Potential for reclamation of used municipal and industrial water are discussed in terms of direct reuse (recirculating) and indirect reuse (effluent from upstream use mixes with streamflow and is withdrawn downstream). Advanced treatment technology is described by processes for the removal of constituents in the effluents, with cost data and a review of major problems. Comparison with desalination and interbasin transfer costs is suggested. Need for research in evaluation and control of virological hazards is stressed. Relationship of advanced treatment processes to secondary treatment processes is included. An optimistic view is presented for the growth of the practice of water reuse, concluding that it will continue with growth of population and industry in the United States.

Gavis, J. and J.F. Ferguson.

The Cycling of Mercury through the Environment.

Water Research. 6:989-1008. 1972.

Key Words: mercury, surface water (fresh), fish.

Abstract:

This paper reviews what is now known about the mercury cycle in the aquatic environment and indicates where the gaps in our knowledge lie. It described the aquatic chemistry of mercury in the presence of chloride ions and the sulfate-sulfide system, the affinity of mercury for the sulfhydryl group in proteinaceous matter, the formation of methylated mercury compounds by microbial mediation, and the tendency for mercury in solution to adsorb on suspended solids. The paper then describes how mercury behaves in a typical local aquatic system based on facts known from its chemistry. It presents, finally, an estimate of the global cycle of mercury, and concludes that although man has created serious local problems by his indiscriminate discharge of mercury into the environment, he has had but negligible effect on a global scale.

Gay, D.W., R.F. Drnevich, E.J. Breider, and K.W. Young.

High Purity Oxygen Aerobic Digestion Experiences at Speedway, Indiana.

In: Municipal Sludge Management; Proceedings of the National Conference on Municipal Sludge Management, 1974. pp. 55-65.

Key Words: suspended solids, aerobic digestion.

Abstract:

A full scale aerobic digestion study utilizing high purity oxygen was performed at the Speedway, Indiana Water Pollution Control Plant. The major purpose of this study was to investigate the possibility of attaining and operating at elevated temperatures without an external heat source. The existing UNOX System was modified so that the entire wastewater flow from the primary clarifier could be handled by one of the two available reactor trains while the other train served as an aerobic digestion unit. The oxygen aerobic digestion process showed the capability of sustaining high temperatures (31°C) during winter operation through the conservation of energy produced by endogenous decay. Volatile suspended solids reductions in excess of 43 percent were obtained with retention times as short as 11.6 days.

Utilizing the data obtained from these tests, a full scale aerobic digestion system using high purity oxygen was designed for Speedway, Indiana. The economic evaluation of the design indicates that the annual cost for aerobically digesting Speedway waste sludge is $53,400 which represents a cost of $34.00 per ton of dry solids treated.

Geldreich, E.E.

Applying Bacteriological Parameters to Recreational Water Quality.

JAWWA. 62(2):113-120. February 1970.

Key Words: coliforms, salmonella, fecal streptococci, surface water (fresh).

Abstract:

Bacteriological measurements of recreational water quality must be based on the detection of fecal contamination by all warm-blooded animals. The fecal coliform test is the most accurate test now available for detecting warm-blooded animal feces in polluted water. Field data from numerous fresh water and estuarine pollution studies indicate a sharp increase in the frequency of salmonella detection when fecal coliform densities are above 200 organisms/100 ml. The inability to detect salmonella in some instances of fecal pollution does not imply poor correlation of the fecal coliform test. It does demonstrate, however, that the occurrence of salmonella is highly variable. Negative results by any salmonella detection methods currently available do not insure the absence of all known salmonella strains nor the absence of other bacterial and viral pathogens.

The fecal streptococcus group encompasses a wide spectrum of strains that have diverse survival rates, specific fecal origins and also includes two biotypes of limited sanitary significance. The S. bovis and S. equinus subgroup is more sensitive to environmental change than any of the other bacterial indicator systems. Their occurrence in water generally indicates that fecal contamination from livestock, ducks, or wild animals has occurred within 24 hr. However, the ubiquitous S. faccalis var. liquifaciens may frequently represent a substantial portion of any fecal streptococcus density in natural waters of good quality. Until better methodology is available which will exclude this streptococcus strain of limited sanitary significance, the use of fecal streptococcus limits below 100 organisms/100 ml of recreational water may be unrealistic unless confirmed by parallel fecal coliform examinations. Fecal coliform bacteria should be used as a baseline indicator system for evaluating the microbiological suitability of recreational waters. The recommended limit of 200 fecal coliforms/100 ml for primary contact recreational water use is both realistic and consistent with research findings and field investigations.

Geldreich, E.E. and A. Kenner.

Concepts of Fecal Streptococci in Stream Pollution.

JWPCF. 41(8):R336-R352. August 1969.

Key Words: fecal streptococci, influent characteristics, effluent characteristics, surface water (fresh).

Abstract:

This article is an excellent discussion on fecal streptococci and their role in environmental pathways.

Geldreich, E.E. and R.H. Bordner.

Fecal Contamination of Fruits and Vegetables during Cultivation and Processing for Market; a Review.

Journal of Milk and Food Technology. 34(4):184-195. April 1971.

Key Words: salmonella, bacteria, groundwater, crops, livestock, agricultural sludge disposal.

Abstract:

Microbiological data from a wide variety of field studies, including fruits, vegetables, related crops, the soils in which they were grown, and the water with which they were irrigated or processed, have been correlated to demonstrate the magnitude of fecal contamination on raw food products. Additional studies point to the many different sources of this contamination in the field and during handling and marketing.

Fecal coliform measurements proved to be the most practical and useful method for determining the degree of disease hazard caused by pathogen occurrence on fruits and vegetables that may be eaten raw. The correlation of fecal coliform densities with the occurrence of salmonella in various stream waters was demonstrated. For values under 1,000 fecal coliforms per 100 ml salmonella occurrence in these streams was 53.5% above this fecal coliform value, the occurrence was 96.4%. This high percentage of salmonella occurrence in water in which there are more than 1,000 fecal coliforms per 100 ml serves to substantiate the validity of the water quality standard recommended by the National Technical Advisory Committee. No quantitative procedure is currently available to measure the pathogen densities that could be present.

In addition to the fecal coliform standard, a series of multiple safeguards against disease infection to be applied during cultivation, irrigation, handling, and processing of salad-type vegetables and fruits are proposed for the protection of public health.

Geldreich, E.E., H.F. Clark, C.B. Huff, and L.C. Best.

Fecal-Coliform-Organism Medium for the Membrane Filter Technique.

JAWWA. 57(2):208-214. February 1965.

Key Words: coliforms, epidemiology.

Abstract:

A medium for fecal coliform organisms (MFC) is recommended that contains no inhibitory substances for coliform bacteria and that depends on an incubation temperature of 44.5°C (±0.5°) for 24 hrs (± 2 hrs) for its selectivity.

Gelperin, A.

Health Effects of Nitrates in Water (Panel Discussion).

Key Words: nitrates, drinking and recreational water, groundwater.

Abstract:

A general discussion of several different investigations into the deleterious effects of "excess" nitrates, especially effects such as methemoglobinemia in infants, is given. One investigation involves two sets of Illinois counties in an effort to compare the physiological effects to residents using high nitrate or low nitrate water supplies. An additional investigation is concerned with methemoglobin tests on newborn babies and their mothers. Data from the hospital test as well as specimens of well water and also a third set of data correlating cancer-related statistics with nitrate levels are submitted to the Department of Preventive Medicine at the University of Chicago. These studies have not only health implications but also economic ramifications.

Geochemical Cycles for Heavy Metals. II. Flow, Geochemical Regulation and Fate of Cadmium in the Environment: an Example of Present Knowledge and Research Needs in the Area of Metal Pollutants (Draft).

April 12, 1976.

Key Words: mercury, lead, cadmium, air, direct contact, surface water (fresh), surface water (marine).

Abstract:

The case of mercury pollution has clearly demonstrated the profound importance of gaining a fundamental understanding of biologically mediated transformation reactions which lead to metal-organic compounds with high bioaccumulation potential and toxicity. In extrapolating our experience with the mercury cycle to other metals, cadmium is not capable of forming stable metal alkyls. It is useful to consider the environmental behavior of cadmium from the perspective of similarities and differences with mercury, as a way of illustrating the gaps in our knowledge which make it difficult at present to pass beyond a qualitative understanding of the factors which determine biological hazard, human exposure, and fate of cadmium as a function of source strengths on a regional or global basis.

George, A. and O.T. Zajicek.

Ion Exchange Equilibria. Chloride-Phosphate Exchange with a Strong Base Anion Exchanger.

Environmental Science and Technology. 2(7):540-542. July 1968.

Key Words: phosphates, adsorption/ion exchange.

Abstract:

From the results obtained in this work it seems that the electroselectivity principle is applicable to the removal of phosphates from water using ion exchange techniques, when the competing ions behave as does chloride. An important question relating to the success of phosphate removal from water is whether the exchanger will be sufficiently selective toward phosphate to enable its exchange, even in the presence of large amounts of competing ions. The results of this study indicate that the resin becomes more selective for phosphate as either the relative or the absolute amount of phosphate decreases. This is particularly important for the removal of pollutant phosphate from a water supply, for example. If the phosphate concentration is high, an ion exchanger will probably remove phosphate; however, as the phosphate concentation decreases, its concentration relative to other ions present becomes small. These results indicate that the selectivity of the exchanger for phosphate should increase, rather than decrease, as phosphate is removed.

While the ultimate test of the efficacy of ion exchangers in removing phosphates from natural waters should require a field test, this study strongly suggests that such a test could be made with a reasonable chance of success. In the solution with $X_p = 0.1$ and a total normality of 0.0075, the phosphate was reduced from about 12 p.p.m. of P to less than 0.01 p.p.m. even in the presence of a ninefold excess of chloride initially.

Gerakis, P.A. and A.G. Sficas.

The Presence and Cycling of Pesticides in the Ecosphere.

Residue Reviews. 52:69-87. 1974.

Key Words: DDE, DDT, chlorinated hydrocarbons, endrin, surface water (fresh).

Abstract:

This is a good review of the mobility of pesticides in the environment. It provides a useful background to pesticides.

Gerba, C.P. and G.E. Schaiberger.

Effect of Particulates on Virus Survival in Seawater.

JWPCF. 47(1):93-103. January 1975.

Key Words: viruses, surface water (marine).

Abstract:

Because seawater is a solution composed of an abundance of ionic forms, it seemed conceivable that the virus might behave differently in this type of environment toward the kaolinite. Also, hydrogen ion concentration has been shown to influence the adsorption of viruses, and the high pH of seawater could alter the ability of the viruses to attach to the surfaces of the clay. Previous experiments had made it conceivable that viral survival could be prompted by the direct adsorption of virions to clay particles; thus, viral adsorption to kaolinite in natural and artificial seawater was next studied.

Gerba, C.P., M.D. Sobsey, C. Wallis, and J.L. Melnick.

Adsorption of Poliovirus onto Activated Carbon in Wastewater.

Environmental Science and Technology. 9:727-731. August 1975.

Key Words: polio virus, adsorption/ion exchange.

Abstract:

The effect of pH and soluble organic matter on virus adsorption to activated carbon in treated sewage was determined. Poliovirus removal from wastewater effluent was greatly improved by lowering the pH to 3.5-4.5 or by reducing the amount of organics by lime coagulation. Batch studies indicated that virus adsorption to activated carbon in wastewater could be described by Freundlich isotherms. In column experiments virus removal was found to be dependent on column length as well as hydraulic loading. Virus and soluble organics adsorbed at low pH could become readsorbed by a rise in pH.

Gerba, C.P., et al.

Enhancement of Poliovirus Adsorption in Wastewater on Activated Carbon.

In: Virus Survival in Water and Wastewater Systems, J.F. Malina, Jr. and B.P. Sagik, eds. University of Texas at Austin, Center for Research in Water Resources, 1974. pp. 115-126.

Key Words: viruses, adsorption/ion exchange.

Abstract:

Batch studies showed that virus adsorption to activated carbon in wastewater could be described by Freundlich isotherms. The isotherms afforded a convenient means of studying the effects of pH and different sewage treatment methods on the efficiency of virus adsorption by activated carbon. The Freundlich plots for the adsorption data of replicate experiments conducted with different batches of sewage had different slopes and y-intercepts. These differences were attributed to differences in the amount and/or the type of organic matter present which competes with the virus for adsorption sites on the activated carbon. This competition was borne out with batch studies which indicated that the amount of virus adsorbed to a given amount of carbon was reciprocally related to the concentration of sewage organics. This conclusion was also supported by the greater degree of virus adsorption in lime-treated sewage than in filtered sewage. Lime clarification of secondary effluent resulted in 25 to 50 percent reductions in absorbance values, indicating appreciable reductions in the amount of organics.

In column studies efficiency of virus removal was found to be dependent on hydraulic loading, with greater removals achieved at a lower loading. No apparent overall increase in virus removal efficiency was achieved by an increase in column length, but the time for the virus exhaustion point to be reached in terms of bed volumes was greater. The 56-inch column was operated over a period of three days as compared with 12 to 24 hours for the 18-inch column.

The adsorption of virus was found to be dependent on pH with the greatest removal being achieved below a pH = 4.5. The pH of the sewage used in this study was found to vary from pH = 7.5 to pH = 8.5. In this pH range, viral adsorption was found to be minimal. Poliovirus has been found to have two isoelectric points at about pH = 7 and pH = 4.5, with the virus becoming positively charged and exhibiting positive mobilities below pH = 4.5. Activated

carbon particles have negative mobilities above pH = 2.4. A positive charge on the poliovirus particle below pH = 4.5 may act to enhance electrostatic attraction onto the negatively charged groups of the activated carbon. Because other enteroviruses also are known to adsorb more readily to surfaces at a low pH in the presence of organic matter, their enhanced adsorption onto activated carbon would also be expected at a low pH.

In summary, the results of the studies suggest that virus removal from wastewater effluent by activated carbon is greatly improved by maintaining a pH = 3.5 to pH = 4.5 or by reducing the amount of wastewater organics by lime coagulation. In the studies, activated carbon adsorption of organic pollutants from wastewater at pH = 4.5 or below was comparable to that at pH = 8. In addition, Weber has shown that activated carbon adsorption of certain organic water pollutants may actually be enhanced at acidic pH levels. Therefore, pH adjustments to below a pH = 4.5 could be applied to a final polishing column of activated carbon to ensure maximum virus removal as well as removal of other organic pollutants. Additional studies would be required to determine if carbon column operation under acidic conditions is both practical and economically feasible.

Gerba, C.P., C. Wallis, and J.L. Melnick.

Viruses in Water: The Problem, Some Solutions.

Environmental Science and Technology. 9(13):1122-1126.
December 1975.

Key Words: viruses, shellfish, groundwater, sanitary landfill, surface water (fresh), surface water (marine), air, direct contact, ponding/land application, gravity separators, filtration, activated sludge, chemical treatment, adsorption/ion exchange, chlorination, ozonation.

Abstract:

This is an excellent review, although general. It discusses both treatment, method, and environmental pathways.

Ghan, H.B., C. Chen, and R.P. Miele.

Disinfection and Color Removal with Ozone (Draft Report).

EPA Advanced Waste Treatment Research Laboratory.
Cincinnati, Ohio.

Key Words: bacteria, ozonation.

Abstract:
The attempts made in this study to reveal the technical and economic virtues of the ozonation process for tertiary treatment, particularly for disinfection and color removal, have been fairly successful.

Ghan, H. B., C. Chen, R.P. Miele, and I.J. Kugelman.

Wastewater Disinfection with Ozone Works Best with a Clean Effluent and Multiple, Low-Dosage Injection Points.

The Bulletin (California Water Pollution Control Association). 12(2):47-53. October 1975.

Key Words: coliforms, suspended solids, COD, ammonia, nitrates, nitrites, ozonation.

Abstract:

Good ozone dissolution can be obtained with spargers, a positive-pressure injector and a sliding vane mixing pump.

Dissolution efficiencies of 90% or greater were observed with all these systems.

Although the high efficiency of the sparger is limited to an ozone dosage of 5 mg/l, it is believed to be the most practical device for adding ozone.

The ozone dosage required to meet a disinfection criterion of total coliform equal to or less than 2.2/100 ml was observed to be a function of effluent quality.

Effluents with low concentrations of color-producing substances, suspended solids, turbidity and COD required 10 mg/l of ozone to meet the requirement; while an effluent with high concentrations of these substances met the criterion only at ozone dosages in excess of 50 mg/l.

The most effective time for disinfection with ozone was in the initial 120 seconds.

Ozone is an effective color-removal agent. The removal of color occurred within the first 120 seconds after ozone addition.

Some removal of total and dissolved COD, suspended solids and turbidity was accomplished in all the process effluents.

A wide variation of results was obtained for these removals, and no correlation with the ozone dosages could be established.

The NH_3-N in all the process effluents was not affected by the ozone, but NO_2-N was easily oxidized to NO_3-N.

The ozonation cost was estimated at 1.6 cents/kl for a good-quality effluent.

Ghosh, M.M. and P.D. Zugger.

Toxic Effects of Mercury on the Activated Sludge Process.

JWPCF. 45(3):424-433. March 1973.

Key Words: mercury, activated sludge.

Abstract:

A preliminary study was conducted to determine the effect of mercury dosed as $HgCl_2$ on a batch-fed system of microorganisms similar to that found in the activated sludge process. The experimental batch units had an initial MLVSS concentration of 2,000 mg/l and F:M ratio of 1.0. The results of this investigation indicate that mercury at concentrations less than 2.5 mg/l as Hg^{2+} has little effect on the activity of a mixed aerobic biomass. However, at a dosage of 5.0 mg/l or higher, aerobic biological processes are definitely inhibited.

After 1 hr, the COD removal in the system dosed with 5.0 mg/l of Hg^{2+} was 55 percent of that for the control; the values of oxygen uptake rate and MLVSS growth were 50 and 25 percent of the respective values for the control. At a dosage of 10.0 mg/l of Hg^{2+}, the COD removal after 1 hr was 33 percent, oxygen uptake rate 15 percent, and MLVSS growth 19 percent of the respective values for the control. In the present study, the threshold toxicity level of mercury seemed to lie between 2.5 and 5.0 mg/l as Hg^{2+}.

The inhibitory effect of mercury is temporary. It is possible for an aerobic biological process to acclimate to a moderately high dosage of mercury. The time required for acclimation increases with the dosage of mercury applied to the system. At a dosage of 5.0 mg/l, a maximum COD removal of 86 percent was accomplished within 5 hr, and that at a dosage of 10.0 mg/l was 82 percent, accomplished in 9 hr. The maximum COD removal in the control was 93 percent, occurring within 3 hr.

Gibbs, R.H., Jr., E. Jarosewich, and H.L. Windom.

Heavy Metal Concentrations in Museum Fish Specimens: Effects of Preservatives and Time.

Science. 184(4135):475-477. April 26, 1974.

Key Words: mercury, cadmium, copper, lead, zinc, fish.

Abstract:

Specimens of myctophid fish preserved for 1 month in formalin, ethyl alcohol, and isopropyl alcohol had higher concentrations of cadmium, copper, zinc, and sometimes lead, and lower concentrations of mercury and sometimes lead, than did unpreserved frozen specimens. Properties of the preservatives and species differences in fish tissues both influence these metal concentrations. Maximum concentrations of some metals in preserved specimens appear to be attained within a month, while concentrations of others may continue to increase for years. Metal tags or other materials in the preservative may cause higher maximum concentrations than the preservatives alone. Comparisons of concentrations of metals between museum specimens and unpreserved (frozen) specimens must be considered unreliable until the changes from preservation are understood.

Gibbs, R.J.

Mechanisms of Trace Metal Transport in Rivers.

Science. 180:71-73. April 1973.

Key Words: copper, chromium, manganese, iron, nickel, cobalt, surface water (fresh).

Abstract:

Trace metals transported by the Amazon and Yukon Rivers were analytically partitioned among the transport phases: in solutions, ion exchange, organic materials, metallic coatings, and crystalline solids. The distribution for both rivers is similarly proportioned, with copper and chromium transported mainly in the crystalline solids, manganese in coatings, and iron, nickel, and cobalt distributed equally between precipitated metallic coatings and crystalline solids.

Gibney, L.

EPA Seeks Substitutes for Banned Pesticides.

Chemical and Engineering News. 53(23):15-16. June 9, 1975.

Key Words: DDT, dieldrin, aldrin, epidemiology.

Abstract:

The Environmental Protection Agency is well under way with a program to identify pesticides that can act as substitutes for other pesticides that have either been banned or face the threat of being banned. Thus far, 40 products have been identified as probable substitutes for problem pesticides. The review of possible substitutes takes into account both scientific and economic factors. Scientific considerations include the chemistry, toxicology, pharmacology, and environmental fate of the product. Economic considerations include the costs and benefits to the user and to society of increased use of the substitute. To date, the agency has studied substitutes for aldrin, dieldrin, and DDT which have been banned; for chlordane and heptachlor which are in litigation; for 2,4,5-T; and for ethylenebisdithiocarbamate. It has been confirmed that methyl parathion, parathion, malathion, phorate, and demeton are fully suitable to act as substitutes for certain uses of DDT, and bromacil for certain uses of 2,4,5-T. For each substitute a report is issued giving the scientific data base for the chemical and also a position paper on the pesticides safety and efficiency. The research effort backing up the substitute chemicals program, besides providing the scientific and economic bases for the program, also provides data with respect to analytical methods, environmental monitoring techniques, and human effect testing procedures. There are 4 major subject areas: toxicological methodologies and evaluation research; screening techniques for "genesis" problems; acceptable and usable alternative methods of pest control; and movement and fate of pesticides in the environment.

Gilbert, R.G., R.C. Rice, H. Bouwer, C.P. Gerba, C. Wallace, and J.L. Melnick.

Wastewater Renovation and Reuse: Virus Removal by Soil Filtration.

Science. 192:1004-1005. June 4, 1976.

Key Words: viruses, ponding/land application.

Abstract:

Secondary sewage effluent and renovated water from four wells at the Flushing Meadows Wastewater Renovation Project, in operation since 1967, were assayed bimonthly in 1974 for viruses during flooding periods. Viruses, regularly found in the secondary effluent, were not detected in any renovated water samples. Results indicated that human viral pathogens do not move through soil into the groundwater, but are apparently absorbed and degraded by the soil and reduced in numbers by a factor of at least 4 logs (99.99 percent removal).

Gilcreas, F.W. and S.M. Kelly.

Relation of Coliform-Organism Test to Enteric-Virus Pollution.

JAWWA. 47(7):683-694. July 1955.

Key Words: coliforms, drinking and recreational water.

Abstract:

Although the experiments presented yield additional data concerning the problem under discussion, they are not directly applicable to water works practice, as they were carried out under laboratory conditions rather than on a plant scale. The results suggest that the coliform index is, in general, a valid measure of pollution, both bacterial and viral, and that it is also a reliable indication of the efficiency of treatment processes when the limitations of marginal treatments in the removal of pollution - particularly by enteric viruses - are understood. The coliform index should be interpreted with discretion and regard for the information available concerning the relative survival rates of the agents in question under conditions of water treatment. The experiments indicate that effective and complete treatment of water is necessary to insure safety from potential pollution by enteric viruses. Marginal treatments are not sufficient, even though they may reduce the density of the coliform group to conform closely with established water quality standards. Much further investigative work on the problem is needed to determine the fundamental significance of the coliform group - compared with viruses and other pathogenic agents - an an indicator of pollution. Epidemiologic studies are also necessary for determining infective densities of viruses in water as compared with coliform microorganisms. It is possible that, although enteric pathogenic viruses are not completely destroyed by present-day water supply treatment, they may be so reduced in numbers that they would not be infective to consumers. Pending further investigation of the problem, it seems safe to state that the coliform index is still a reliable indicator of significant pollution and of the effectiveness of standard water supply treatment.

Gilde, L.C., A.S. Kester, J.P. Law, C.H. Neeley, and D.M. Parmelee.

A Spray Irrigation System for Treatment of Cannery Wastes.

JWPCF. 43(10):2011-2025. October 1971.

Kew Words: BOD, bacteria, ponding/land application.

Abstract:

The 12-month cooperative research program was initiated to learn more about the microbiology, microclimate, forage quality, yield, and treatment efficiency of a unique spray irrigation system. Hydraulic measurements were made to account for the liquid applied. Chemical analysis of the wastewater surface runoff, soil percolate, and final effluent as well as the hydraulic data provided the means to account for removal efficiencies on a mass balance basis. Particular attention was given to the fate of the nitrogen and phosphorus compounds. The treated effluent released to the surface stream leaving the farm consistently had a BOD content of less than 10 mg/l with about half the data being less than 6 mg/l.

The studies have shown that much of the plant nutrient material that is released during the decomposition of organic matter contained in the wastewater is reabsorbed by the soil complex. The capacity of an arable soil for the retention of vast quantities of plant nutrients is a well-established agricultural fact. Nonetheless, it is not reasonable to suppose that this storage capacity is infinite. One way of prolonging the plant nutrient storage capacity is to remove the nutrients by harvesting the hay.

Gillet, J.W., J. Hill IV, A.W. Jarvinen, and W. P. Schoor.

A Conceptual Model for the Movement of Pesticides Through the Environment: A Contribution of the EPA Alternative Chemicals Program.

EPA/660/3-74/024, National Ecological Research Laboratory, Corvallis, Ore., December 1974. 89p. (Available from National Technical Information Service (NTIS) as PB-238 653).

Key Words: pesticides, surface water (fresh), surface water (marine).

Abstract:

The report presents a conceptual model of the movement and disposition of pesticides in the environment. A multi-media model is built up from simple modules representing basic processes and components of air, soil, and water. More specific models are exposited for the atmospheric/terrestrial, freshwater aquatic, and estuarine/marine environments. Ultimately systems analysis and mathematical simulation techniques can be employed to evaluate the fate of a specific chemical in a particular environment. The conceptual model is thus a first step in organizing facts, assumptions, and hypotheses into a graphic and logical arm capable of exploitation in further experimentation of pesticide disposition and effects. A multi-media approach to disposition studies is made explicit even in the absence of a single all-media global model.

Gilliam, J.W., R.B. Daniels, and J.F. Lutz.

Nitrogen Content of Shallow Ground Water in the North Carolina Coastal Plain.

Journal of Environmental Quality. 3:147-151. April 1974.

Key Words: ammonia, nitrates, nitrites, groundwater.

Abstract:

The NO_3-N and NH_4-N concentrations in shallow (<3 m) groundwater under a range of soil types, drainage conditions, and type of crop grown were monitored. The NO_3-N levels were always low (1 ppm or less) in groundwater under wooded areas. The concentrations were somewhat higher under cultivated fields with the levels usually being 1 to 5 ppm although several values in the range of 10 to 20 ppm were recorded. The concentrations in all wells were always higher during the winter months. There seemed to be no relationship between cultivated crop and NO_3-N in the groundwater. The NO_3-N concentration was almost always higher in the middle of the field than on the edge of the field even though the direction of water flow was toward the edge of the field. It is suggested that denitrification is responsible for this decrease.

There was little difference in NH_4-N concentration in water under cultivated fields and under unfertilized woods or pasture. The NH_4-N concentrations were normally in the range of 0.1 to 1 ppm with the higher levels being found under poorly-drained soils.

Based upon the characteristics of the surface sediments, it is concluded that very little of the NO_3-N present in the shallow groundwater moves into deep aquifers in any area of the North Carolina Coastal Plain. However, the amount of NO_3-N that moves through the surficial sediments to the streams probably varies with location and characteristics of the confining beds.

Giusti, D.M., R.A. Conway, and C.T. Lawson.

Activated Carbon Adsorption of Petrochemicals.

JWPCF. 46(5):947-965. May 1974.

Key Words: oil and grease, synthetic/organics,
adsorption/ion exchange.

Abstract:

Studies with 93 petrochemicals dosed singly with activated carbon show that as molecular weight increases and polarity, solubility, and branching decrease, the degree to which pure components are adsorbed by activated carbon increases somewhat predictably.

Of the classes of compounds studied, the aromatics exhibited the greatest amenability to activated carbon adsorption because of their relatively low solubilities in aqueous solution and bonding to the aromatic surface of the activated carbon.

Functionality was seen to have a substantial effect, which was interrelated with solubility and polarity. For the straight-chain compounds, the relative amenabilities to carbon adsorption for compounds of less than four carbons were: undissociated organic acids > aldehydes > esters ketones > alcohols > glycols. For compounds above four carbons, the alcohols moved ahead of the esters.

For representative compounds from the five functional groupings studied in isotherm tests, the amenability to adsorption increased with decreasing total surface acidity of the carbon. Consequently, for compounds of this type, a carbon of low surface acidity is indicated. Also, the method of regeneration of the carbon should prevent addition or rearrangement of surface oxides. The possibility exists that other compounds show a reverse of this effect, such as urea in Coughlin's findings. With this in mind, a mixture of carbons, each suitable for a specific compound, conceivably could be used on a waste stream of known and relatively consistent make-up.

An increased adsorptive capacity was noted for the test compounds at high pH levels, apparently because of the opening of micropores blocked by surface oxide structures and at times by the formation of higher molecular-weight condensation products.

Pretreatment of carbons for isotherm testing did not manifest itself as being solely responsible for the relatively high ultimate capacities found for carbons in batch-type

equilibrium tests as opposed to the lower capacities observed in continuous systems. This tentative conclusion is based on data for only two compounds. Such factors as channeling, variation in flow rate, and insufficient residence time are probably the main contributors to the apparently lower capacities in continuous systems.

Adsorption from certain 2-component systems was found in isotherm tests to be fairly predictable from single-component data; however, data with a four-component system indicate that only about 60 percent of the anticipated adsorption was realized, probably because competition for adsorption sites and mutual solubility effects are not negligible at this level.

Adsorption results with three continuous systems indicated greater than 80 percent attainment of the ultimate equilibrium capacities measured in isotherm tests with the pure compounds and mixtures.

Glaser, J.R. and J.O. Ledbetter.

Sizes and Numbers of Aerosols Generated by Activated Sludge Aeration.

Water and Sewage Works. 114(6):219-221. June 1967.

Key Words: bacteria, air.

Abstract:

More than 15,000 particles (without considering those less than 1 micron in size) are emitted by an aeration tank in an activated sludge system. While the average size is 11.8 microns and the large particles would present little health hazard to the plant operators and others in the vicinity, some 40 percent of these particles have diameters less than 10 microns and certainly are respirable and could cause respiratory infections and disorders.

Glaze, W.H. and J.E. Henderson IV.

Formation of Organochlorine Compounds From the Chlorination of a Municipal Secondary Effluent.

JWPCF. 47(10):2511-2515. October 1975.

Key Words: synthetic/organics, chlorination.

Abstract:

Whereas most wastewater treatment processes currently utilize terminal chlorination at rather moderate dosages, there is some interest in using much larger dosages for various specialty applications that are required in plant operation.

In retrospect, it is not surprising to find that chlorination under aqueous conditions produces new chlorinated compounds from the organics found as residues in wastewater effluents. Recently, attention has been focused on the possible deleterious effects of such compounds on receiving streams and on the possible chronic health effects of such compounds should they enter drinking water supplies.

While the "superchlorination" conditions used in the present work do not accurately represent the conditions used in waste treatment plant operation, the new compounds formed thereby will presumably be the same in many cases as those formed in smaller quantities during terminal chlorination. Thus, the identification of 36 new chlorinated organic compounds that were formed by "superchlorination" of a typical secondary effluent is reported herein.

Glover, G.E. and G. R. Herbert.

Microstraining and Disinfection of Combined Sewer Overflows - Phase II.

EPA-R2-73-124, Edison Water Quality Research Laboratory, N.J., January 1973. 119p. (Available from National Technical Information Service (NTIS) as PB-219 879).

Key Words: COD, total dissolved solids, coliforms, suspended solids, BOD, screening operations, influent characteristics, chlorination.

Abstract:

Suspended solids removal performance tends to confirm previous work. The microstrainer operated at flow rates of 35-45 gpm/ft^2 with differentials of 24 inches of water. At these rates, the suspended solids in combined sewer overflow were reduced from 50-700 mg/l to 40-50 mg/l and below. At the higher influent levels of suspended solids, removal performance was enhanced, yielding effluent concentrations of approximately 10 mg/l. The conventionally used, percentage removal performance criteria are not valid for microstraining of combined sewer overflow.

Volatile suspended solids reduction paralleled the reduction of total suspended solids.

The highest concentration of suspended solids frequently occurs when the overflow rate is highest. The concurrence of high suspended solids concentration and high overflow rate results in a very high potential contaminant loading per unit time to the receiving stream.

Gloyna, E.F., S.O. Brady, and H. Lyles.

Use of Aerated Lagoons and Ponds in Refinery and Chemical Waste Treatment.

JWPCF. 41(3):429-439. March 1969.

Key Words: BOD, COD, suspended solids, aerated lagoons.

Abstract:

This article gives wastewater characteristics of refinery waste.

Godfrey, K.A., Jr.

Land Treatment of Municipal Sewage.

Civil Engineering. 43(9):103-109. September 1973.

Key Words: BOD, suspended solids, viruses, elemental contaminants, ponding/land application, groundwater.

Abstract:

Engineers and ecologists are debating the pros and cons of applying treated sewage effluents to land, as a treatment process and to recycle nutrients. Instead of polluting streams, most of the organic matter and nutrients in sewage would be recycled to the land, boosting growth of grass, crops, or forests. Certain types of land treatment demand huge land areas. To date the approach has often been used in the arid Southwest - primarily for water reclamation rather than pollution control. But with the new, stricter pollution-control laws, the process may now see increased use in humid areas.

Good as land treatment is, caution is needed in designing and operating a facility.

Study each case with great care. In each situation there will be a different combination of climate, sewage character, soil, water and plant life.

Monitor land-treated effluent quality. Nitrate levels in leachate are of particular concern.

Do more research. Particularly in the humid eastern U.S., land treatment has not been tried in a sizeable city. There are unknowns, for example whether nitrate levels in treated leachate will always be acceptably low, what will be the long-term effects of heavy metals applied to the soil, and the fate of viruses.

Earlier land treatment systems were inadequate - no continuous effluent quality monitoring, no performance reporting on a standardized basis, often no underdrains to prevent soil salination and to permit holding the occasional effluent that is of unacceptable quality. But designed with necessary safeguards, land treatment is today a viable method of tertiary treatment.

Goff, G.D., J.C. Spendlove, A.P. Adams, and P.S. Nicholes.

Emission of Microbial Aerosols from Sewage Treatment Plants
That Use Trickling Filters.

Health Service Reports. 88(7):640-651. August-September 1973.

Key Words: biological contaminants, coliforms, bacteria,
trickling filters, air.

Abstract:

This paper discusses emission of microbial aerosols from sewage treatment plants using trickling filters.

Gold, H. and A. Todisco.

Wastewater Reuse by Continuous Ion Exchange.

In: Complete WateReuse. L.K. Cecil, ed. American Institute of Chemical Engineers, New York, 1973. pp. 96-103.

Key Words: BOD, adsorption/ion exchange.

Abstract:

This paper describes an attempt to run a reuse system by ion exchange.

Goldman, J.C. and J.H. Ryther.

Nutrient Transformations in Mass Cultures of Marine Algae.

Journal of the Environmental Engineering Division, ASCE.
101(EE3):351-364. June 1975.

Key Words: nitrates, ammonia, aqua cultures.

Abstract:

The feasibility of growing marine algae in mass culture using wastewater-seawater mixtures as the nutrient source has been demonstrated. Operational control of algal yields and nitrogen removal may be effected through manipulation of the wastewater-seawater mixture or the dilution rate, or both, although geographical location will control ultimate yields through sunlight and temperature effects. In addition, by maintaining NH_4^+ - N as the dominant N form in the wastewater, nitrogen removal can be enhanced significantly by NH_3 evolution to the atmosphere at the high pH values attained in the ponds.

Utilization of the algae for stripping nutrients from wastewater or as a food for shellfish growth in an aquaculture system, or both, may by the desired end result of such a process. Algal yields of 6 g PC m^{-2} day^{-1} were achieved in this study, which may be close to the maximum attainable yields in mass cultures on a sustained basis. Future research in different locales will be required to determine accurately the practical limit to algal production.

Goldman, J.C., K.R. Tenore, J.H. Ryther, and N. Corwin.

Inorganic Nitrogen Removal in a Combined Tertiary Treatment Marine Aquaculture System - I: Removal Efficiencies.

Water Research. 8:45-54. 1974.

Key Words: nitrates, nitrification/denitrification.

Abstract:

The increasing awareness that nitrogen is often a key nutrient controlling algal growth in coastal marine waters has led to a concerted effort to find ways to remove ammonia and nitrate from wastewaters. A novel approach to this problem involves the combining of algal and seaweed nutrient stripping processes with a marine aquaculture. Not only is nitrogen removed from wastewater, but important commercial shellfish and seaweeds are produced.

A prototype process consisting of growth systems for marine algae, oysters and seaweed, joined in series, was fed secondarily treated wastewater, diluted 1:4 with seawater, for 11 weeks during the Summer of 1972. During this time 95 percent of the influent inorganic nitrogen was removed by algal assimilation. The oysters in turn removed 85 percent of the algae, but regenerated as soluble ammonia 16 18 percent of the nitrogen originally bound in the algal cells. All of the regenerated nitrogen was removed in the seaweed system so that the total inorganic nitrogen removal efficiency of the system was 95 percent. Phosphorus removal on the other hand was not nearly as complete as only 45-60 percent was removed.

The process has the capability of being expanded to include additional trophic levels in an integrated and highly controlled food chain system to serve the dual function of tertiary wastewater treatment and waste recycling through the production of shellfish and seaweeds.

Goldman, J.C., K.R. Tenore, and H.I. Stanley.

Inorganic Nitrogen Removal in a Combined Tertiary Treatment Marine Aquaculture System - II: Algal Biomass.

Water Research. 8:55-59. 1974.

Key Words: nitrates, nitrification/denitrification.

Abstract:

Algal bioassays were conducted on samples from various components of the combined tertiary treatment marine aquaculture process, described in PartI of this study. These assays demonstrated that nitrogen removal is necessary to prevent increasing the algal growth potential of coastal marine waters receiving wastewater discharges. When nitrogen was removed from secondarily treated domestic wastewater, the wastewater in varying dilutions with seawater could not support more algal growth than the seawater alone. By adding nitrogen back to the treated wastewater the algal growth potential was increased to that of the untreated wastewater. This was demonstrated by assaying samples containing both artifically added nitrogen, and nitrogen regenerated by oysters. Assays of the effluent from the seaweed system showed that the removal of regenerated nitrogen reduced the algal growth potential to that of natural seawater.

Gossling, J. and J.M. Slack.

Predominant Gram-Positive Bacteria in Human Feces: Numbers, Variety, and Persistence.

Infection and Immunity. 9:719-729. April 1974.

Key Words: bacteria.

Abstract:

The predominant gram-positive bacteria in 47 fecal specimens from 10 healthy men were studied by microscopic and cultural counts, by the characterization and tentative identification of isolates, and by the use of fluorescein isothiocyanite (FITC)-conjugated globulins prepared using some of the isolates. Gram-positive bacteria averaged approximately 10^{10}/g (wet weight) of feces with significant variation from host to host. Characterization of 865 isolates, all strict anaerobes and carbohydrate fermenters, showed 12 to 39 distinguishable strains from each host and indicated that some strains were present the full period of about 18 months. Sixty percent of the isolates belonged to one of five types, all of which had distinct host idiosyncracy in estimated counts.

Grabow, W.O.K.

The Virology of Waste Water Treatment.

Water Research. 2(10):675-701. November 1968.

Key Words: viruses, polio virus, hepatitis virus, activated sludge, surface water (fresh), trickling filters, filtration, adsorption/ion exchange, chlorination, ozonation.

Abstract:

This literature survey shows that we do know that pathogenic viruses may survive undetected under conditions that result in the elimination of coliform organisms; that conventional sewage purification and water treatment procedures merely reduce the numbers of these viruses and that they can be isolated from water supplies even after conventional chlorination that is regarded as satisfactory for removing bacterial contamination. Evidence has furthermore been presented to suggest that a single tissue culture dose ($TCID_{50}$) may be sufficient to infect man if it is placed in contact with susceptible cells. Thus, although there are divergent views on the likelihood that water is an important route in the transmission of viruses, there is general agreement that water could be important as a vehicle of disease transmission. These uncertainties have to be clarified, and our water purification and disinfection methods have to be improved to ensure virus-free drinking water now and in the future.

Grabow, W.O.K. and E.M. Nupen.

The Load of Infectious Microorganisms in the Waste Water of Two South African Hospitals.

Water Research. 6:1557-1563. 1972.

Key Words: bacteria, drinking and recreational water.

Abstract:

Counts of micro-organisms including infectious bacteria, viruses and parasite ova in the waste water of two hospitals were compared with those in city sewage. One of these is an isolation hospital with stringent disinfection procedures. Counts of all the organisms tested, except *Pseudomonas aeruginosa*, were lower in the waste water of this hospital than in the sewage effluent of the town in which it is located. The other hospital is a general hospital with less stringent disinfection procedures. Counts of some organisms were slightly higher in the waste water of this hospital than in the sewage effluent of the city in which it is located. The results obtained indicated that under normal conditions the waste water of hospitals needs no treatment before disposal into city sewers. The disposal of primary treated hospital effluents into streams or their use for irrigation should, however, be considered with care.

Grabow, W.O.K., O.W. Prozesky, and L.S. Smith.

Drug Resistant Coliforms Call for Re-evaluation of Water Quality Standards.

Water Pollution Control. 74(2):217-222. 1975.

Key Words: coliforms, drinking and recreational water, epidemiology.

Abstract:

The therapeutic value of antimicrobial drugs is diminishing due to the rapid increase of resistant bacteria. A current prominent type of resistance is mediated by R factors (extrachromosomal nucleic acid elements) which may cause high level resistance to many drugs. These factors may also provide resistance to other antibacterial agents such as u.v. light, heavy metals, bacteriocins and phages, and may enhance the virulence and infectivity of pathogens. Intestinal Gram-negative bacteria like coliforms may act as reservoirs of R factors and transfer them to pathogens. Evidence is presented that sewage polluted water may play an important role in the spread of coliform and other bacteria carrying R factors. Since coliforms have joined forces with bacteria increasingly involved in disease, they can no longer be regarded as harmless indicators of faecal pollution. This calls for a re-evaluation of water quality standards and for more advanced purification of sewage prior to discharge into the environment.

Grabow, W.O.K., O.W. Prozesky, and L.S. Smith.

Drug Resistant Coliforms Call for Review of Water Quality Standards.

Water Research. 8:1-9. 1974.

Key Words: coliforms, drinking and recreational water.

Abstract:

Two factors are involved in the spread of R^+ bacteria: drug therapy which does not create but selects for resistance plasmids (in patients who had acquired R^+ bacteria, antimicrobial therapy is followed by a rapid increase of these organisms which are discharged into sewage via feces and other excreta) and the transmission of the organisms from excretors to the population at large (sewage seems to be of prime importance in this regard). Two percent of coliforms in sewage and in sewage-polluted water can be expected to carry R factors (maximum 26 percent in a hospital effluent).

Grabow, W.O.K., I.G. Middendorff, and O.W. Prozesky.

Survival in Maturation Ponds of Coliform Bacteria with Transferable Drug Resistance.

Water Research. 7:1589-1597. 1973.

Key Words: coliforms, bacteria.

Abstract:

The behavior of drug-resistant coliform bacteria in a series of sewage maturation ponds was investigated. The average reduction through the ponds of coliforms resistant to ampicillin, chloramphenicol, kanamycin, streptomycin or tetracycline was 6.83 percent lower than that of drug-sensitive bacteria. This difference was mainly due to coliforms with transferable resistance (R^+ coliforms) which increased from 0.86 percent to 2.45 percent through the ponds. The spectrum of transferable resistance of coliforms in the effluent did not differ notably from that of coliforms in the influent. The average incidence of *Escherichia coli* I among R^+ coliforms decreased from 66.08 percent to 62.09 percent. This indicates that low-level transfer of R factors may occur in ponds. Possible mechanisms and the epidemiological significance of the increased survival of R^+ coliforms in maturation ponds are discussed.

Graef, S.P.

Anaerobic Digester Operation at the Metropolitan Sanitary Districts of Greater Chicago.

In: Municipal Sludge Management; Proceedings of the National Conference on Municipal Sludge Management, 1974. pp. 29-35.

Key Words: suspended solids, anaerobic digestion.

Abstract:

The practice of anaerobic sludge digestion by the Metropolitan Sanitary District of Greater Chicago is summarized. Topics discussed include capacities of five digestion facilities, digester construction costs, operation and maintenance costs, sludge conditioning and digester flow regimes, heat transfer, loading intensity, gas production, digested sludge characteristics, sludge disposal, digester problems and future improvements in digester operation.

Graeser, H.J.

Dallas' Wastewater-Reclamation Studies.

JAWWA. 63(10):634-640. October 1971.

Key Words: BOD, COD, suspended solids, trickling filters, adsorption/ion exchange, chemical treatment.

Abstract:
This article is a general discussion of water reuse.

Graeser, H.J.

Water Reuse: Resource of the Future.

JAWWA. 66(10):575-578. October 1974.

Key Words: polio virus, pesticides, chemical treatment, filtration, adsorption/ion exchange.

Abstract:
This article discusses Dallas/EPA research on polio virus, organics, and heavy metals.

Graetz, D.A., L.C. Hammond, and J.M. Davidson.

Nitrate Movement in a Eustis Fine Sand Planted to Millet.

Soil and Crop Science Society of Florida. Proceedings. 33:157-160. November 27-29, 1973.

Key Words: nitrates, chlorides, surface water (fresh), crops.

Abstract:

Movement of N, added as NH_4NO_3, was measured in a Eustis fine sand planted to millet. Significant NO_3 leaching occurred from fertilizer applied at planting as well as from fertilizer applied 6 weeks after planting when the millet was in its rapid growth phase. Nitrification was sufficiently rapid that most of the added NH_4 was converted to NO_3 during the time of this investigation. Water depletion data indicated two periods of drainage from the 150-cm soil profile. This drainage was sufficient to remove essentially all of the Cl and all of the NO_3 not utilized by the soil-plant system. Approximately 42% of the added N was assimilated by the harvested portion of the millet. Another 13% was estimated to remain in the soil in plant roots. Most of the remaining 45% was leached below 150 cm under the climatic conditions encountered during this investigation.

Graetz, D.A., G. Chesters, T.C. Daniel, L.W. Newland, and G.B. Lee.

Parathion Degradation in Lake Sediments.

JWPCF. 42(2):R76-R94. February 1970.

Key Words: chlorinated hydrocarbons, surface water (fresh).

Abstract:

The persistence of parathion in the natural aquatic environment is affected markedly by microbial activity. Without microbial activity, parathion would remain in the environment for several months while in biologically active aerobic or anaerobic environments, it would be degraded in a matter of weeks.

Graham, D.L.

Trace Metal Levels in Intertidal Mollusks of California.

The Veliger. 14(4):365-372. April 1, 1972.

Key Words: cadmium, chromium, copper, manganese, lead, zinc, shellfish.

Abstract:

Determinations of silver, cadmium, chromium, copper, manganese, lead and zinc were made by atomic absorption spectrophotometry on 7 species of mollusks from 11 locations along the California coast from San Francisco Bay to Los Angeles. Separate analyses were performed on shells and soft portions of whole bodies. Highest levels, above 900 ppm lead, 570 ppm copper, and 1700 ppm zinc have raised the question of causes for these concentrations.

Granata, A., L. De Angelis, M. Piscaglia, et al.

Relationship between Cancer Mortality and Urban Drinking Water Metal Ion Content.

Minerva Medica. 61:1941. May 1970.

Key Words: epidemiology, drinking and recreational water.

Abstract:

A relationship between cancer mortality and drinking water metal ion content appears to exist.

Grande, M.

Effect of Copper and Zinc on Salmonid Fishes.

Advances in Water Pollution Research. 1966(1):97-111.

Key Words: copper, zinc, surface water (fresh), fish.

Abstract:

This paper is a valuable contribution to the literature on the complex problem of the effect of copper and zinc on salmonid fishes.

Grande, M.

Effect of Copper and Zinc on Salmonid Fishes.

Munich Abstracts - Section I. 38(3):317-318. March 1966.

Key Words: copper, zinc, surface water (fresh), fish.

Abstract:

The experiments with eggs showed that copper inhibited their development in about the same concentrations that were toxic to fry. Zinc, on the other hand, was found to have a more specific effect on the development of eggs, in concentrations less than 1/10 of those toxic to fry, i.e., less than 0.05 mg/l.

Graves, J.O., Jr.

Enteric Bacteriophages in Saint Louis Bay, Mississippi.

University of Mississippi, University, Dept. of Biology,
May 1972. 34p. (Available from National Technical
Information Service (NTIS) as COM-75-10028/9WP).

Key Words: bacteria, *Escherichia coli*, salmonella, shigella, surface water (fresh).

Abstract:

Samples from four stations in Saint Louis Bay, Mississippi were examined monthly for the presence of enteric bacteriophages over the period from July 1971 to March 1972. The samples were of surface and bottom water, bottom sediment, and surface and gut of fish and oysters. Host bacteria tested were *Escherichia coli*, *Enterobacter aerogenes*, *Salmonella schottmuelleri* and *Shigella alkalescens*. No bacteriophages for *Salmonella schottmuelleri* or *Shigella alkalescens* were detected. Bacteriophages of *Escherichia coli* and *Enterobacter aerogenes* were isolated regularly, most commonly from surface water samples. MPN estimations of *E. coli* bacteriophage concentrations in surface water samples were determined over the period from December to March. Wide variations in *E. coli* bacteriophage concentrations were encountered. The data indicated a pattern of seasonal variation. This method provided a rapid and simple means for estimation of coliphage concentrations in water.

Gray, D.H. and C. Penessis.

Engineering Properties of Sludge Ash.

JWPCF. 44(5):847-858. May 1972.

Key Words: COD, incineration.

Abstract:
This is a general discussion of residue remaining from sludge incineration.

Greenberg, A.E.

Survival of Enteric Organic Organisms in Sea Water.

Public Health Reports. 71(1):77-86. January 1956.

Key Words: bacteria, surface water (marine), drinking and recreational water.

Abstract:

From a review of the literature on the survival of enteric organisms in seawater, it is apparent that these organisms can create a health hazard in estuaries, bays, and especially beaches. The rate of disappearance of the fecal bacteria is greater than that which would be expected from dilution alone. A number of factors are implicated. These include the production by marine bacteria of unidentified, heat labile antibiotic substances; and adsorption and sedimentation, predation, and competition for the limited food supply. The net result is a partial or complete disinfection or self-purification of seawater. Nevertheless, this bacterial destruction should not be relied on as the sole protection offered to users of seawater.

Greenberg, A.E. and E. Kupka.

Tuberculosis Transmission by Waste Waters - A Review.

Sewage and Industrial Wastes. 29(5):524-537. May 1957.

Key Words: epidemiology, chlorination, drinking and
recreational water.

Abstract:

From a review of the literature on sewage, tubercle bacilli, and tuberculosis as a clinical disease, it is apparent that health hazards may exist in the disposal of tuberculous material.

An attempt was made to answer several questions regarding tuberculosis and sewage. The following conclusions appear justified:

1. The wastes from institutions treating tuberculosis patients will almost always contain large numbers of tubercle bacilli. Disinfection of sputum and of other discharges from patients will reduce the numbers of tubercle bacilli found in sewage, but will not eliminate them.

2. Industries, such as dairies and slaughter houses, handling tuberculous animals, may be expected to discharge tubercle bacilli with their wastes.

3. Conventional sewage treatment is inadequate to significantly reduce the number of tubercle bacilli in the sewage. In order to provide adequate disinfection, complete treatment plus chlorination is necessary. The chlorine dose for a well-oxidized effluent should be at least 20 p.p.m. and the chlorine contact time should be at least 2 hr.

4. Contaminated sewage or water can produce typical tuberculosis in humans. The danger is most marked with swimming and near-drowning, but the danger associated with other uses should not be minimized, nor neglected and, at the very least, it should be kept in mind.

Greer, D.E. and C.D. Ziebell.

Biological Removal of Phosphates from Water.

JWPCF. 44(12):2342-2348. December 1972.

Key Words: phosphates, tertiary treatment.

Abstract:

The removal of excess phosphates by precipitation in the form of hydroxyl-apatile without the addition of any reagents is a feasible technique in areas possessing alkaline waters. This precipitation process is implemented by elevation of the OH^- ion concentration through the removal of CO_2 from the water by algae. The resulting hydroxyl-apatite-algae suspension can be removed from the water by beds of clams. The clams used in this research, Corbicula fluminea, can live in eutrophic water if the water is circulated continuously and the water temperature is maintained below 30°C.

This tertiary treatment technique is capable of removing phosphorus from 15.0 mg/l PO_4^{3-} solution at the rate of 0.930 mg/day without the addition of any reagents. Further research and engineering planning may enhance this removal rate appreciably.

Gregor, C.D.

Solubilization of Lead in Lakes and Reservoir Sediments by NTA.

Environmental Science and Technology. 6(3):278-279. March 1972.

Key Words: lead, surface water (fresh).

Abstract:

The proposed replacement of phosphate by nitrilotriacetic acid (NTA) in detergent formulations could result in the latter compound finding its way into public water supplies. Reservoir bottom sediments frequently contain insoluble lead deposited from automobile exhausts. The possibility of NTA solubilizing significant amounts of lead into drinking water was investigated by shaking suburban reservoir and lake sediments with water containing NTA. A concentration of soluble lead 12 times the maximum permitted level was observed in certain experiments.

Greichus, Y.A., A. Greichus, and R.J. Emerick.

Insecticides, Polychlorinated Biphenyls and Mercury in Wild Cormorants, Pelicans, Their Eggs, Food, and Environment.

Bulletin of Environmental Contamination and Toxicology.
9:321-328. June 1973.

Key Words: chlorinated hydrocarbons, mercury, fish, surface water (fresh).

Abstract:

In this article, levels of organochlorine insecticides, PCB's, and mercury in bottom sediments, fish, and birds in a freshwater ecosystem are examined.

Grigoropoulos, S.G., R.C. Vidder, and D.W. Max.

Fate of Aluminum-Precipitated Phosphorus in Activated Sludge and Anaerobic Digestion.

JWPCF. 43(12):2366-2382. December 1971.

Key Words: phosphates, chemical treatment, anaerobic digestion, activated sludge.

Abstract:

On the basis of the findings of this study, the following conclusions may be drawn:

1. Sodium aluminate and alum added directly to the activated sludge aeration chamber were capable of precipitating phosphorus and effecting a sizable reduction in the phosphorus content of the influent wastewater; the degree of phosphorus removal depended primarily on the type of precipitant and the Al:P ratio used and the influent phosphorus concentration.

2. Aluminum to phosphorus molar ratios in excess of the stoichiometric 1:1 ratio for the formation of aluminum phosphate were needed in order to obtain a low residual total phosphorus concentration in the effluent; ratios of 1.3 and 1.9 were found optimum with alum and sodium aluminate, respectively.

3. The presence of sodium aluminate and alum did not adversely affect the treatment efficiency of the activated sludge process; the removal of COD averaged approximately 90 percent throughout the study, the sludge had better settling characteristics, and the overall stability of the system was improved.

4. The addition of sodium aluminate and alum greatly increased the amount of MLSS and MLVSS produced by the system; however, the volatile fraction decreased from 80 to about 50 percent.

5. Aluminum-precipitated phosphorus was concentrated in the sludge of the anaerobic digester and was not released during the digestion process; on the contrary, the supernatants from the digesters which had been fed with sludge containing chemically precipitated phosphorus had less phosphorus than the supernatant from the control digester.

6. An increase in the aluminum content of the digester sludge (up to 1,700 mg/l) exerted no toxic effects on the anaerobic digestion process, as evidenced by the volatile acids and gas production characteristics of the test digesters compared to those of the control digester.

Grinstein, S., J.L. Melnick, and C. Wallis.

Virus Isolations from Sewage and from a Stream Receiving Effluents of Sewage Treatment Plants.

Bulletin of the World Health Organization. 42:291-296. 1970.

Key Words: viruses, drinking and recreational water, surface water (fresh).

Abstract:

In order to detect viruses in sewage or streams, it is first necessary to concentrate the virus present in the fluid sample. Available methods are not readily manageable for concentrating virus from large volumes of fluid, and have not always yielded high recovery rates. In the study described in this paper, a method for concentration of viruses by adsorption on insoluble cross-linked maleic anhydride polyelectrolytes has been utilized to survey the viral flora of sewage and of a stream receiving sewage effluents, in a residential area of Houston, Texas. On a single day the virus flow at different points along the stream varied from 304,000 to 6,014,000 PFU/min. From 84 samples each of 1 US gal, 14,520 isolates were obtained, chiefly echovirus type 7 and polioviruses of all 3 types, some of them with characteristics of virulent wild strains. With virus isolation rates as high as those achieved, it is now possible to monitor virus in natural waters more effectively.

Grover, R.

Adsorption and Desorption of Trifluralin, Triallate, and Diallate by Various Adsorbents.

Weed Science. 22:405-408. July 1974.

Key Words: herbicides, adsorption/ion exchange.

Abstract:
This herbicide will be removed by adsorption. The relative adsorption of trifluralin, triallate, and diallate was studied on several adsorptive surfaces. The herbicides were strongly adsorbed, with the general trend: activated charcoal > peatmoss, wheat straw cellulose triacetate cation exchange resin > anion exchange resin > silica gel > cellulose powder. Trifluralin and triallate were readily desorbed from montmorillonite by water, with minimal desorption for peatmoss, cellulose triacetate, and wheat straw.

Grover, R. and A.E. Smith.

Adsorption Studies with the Acid and Dimethylamine Forms of 2,4-D and Dicambra.

Canadian Journal of Soil Science. 54:179-186. May 1974.

Key Words: herbicides, adsorption/ion exchange.

Abstract:

The amount of adsorption of both the acid and dimethylamine forms of the two herbicides was minimal in prairie soils. Both forms of both herbicides were strongly adsorbed to activated charcoal and anion-exchange resin.

Gruenwald, A.

Drinking Water from Sewage?

The American City. 82(3):92-93. March 1967.

Key Words: ammonia, nitrates, nitrites, phosphates, BOD, chromium, iron, copper, manganese, cadmium, nickel, influent characteristics, effluent characteristics.

Abstract:

This is a general discussion on renovation of wastewater for direct use.

Grunniger, R.M.

Disposal of Waste Alum Sludge from Water Treatment Plants.

JWPCF. 47(3):543-552. March 1975.

Key Words: suspended solids, gravity thickeners, centrifugal thickeners.

Abstract:

Basic data that would enable rapid advancement in the technology of treating water treatment plant sludges are not readily available. Experience in treating alum sludges at four water treatment plants in western New York indicates that the characteristics of the sludges are affected by the substances used in the water treatment process and may be highly variable. At the three plants of similar design in Monroe County, similar raw water sources produce sludges of similar quality. Sludges that were investigated could readily be thickened by gravity to about 2 percent solids and then dewatered mechanically to concentrations suitable for land disposal of the residue.

The alternative mechanical dewatering systems that seem to be most practicable and that are able to achieve consistently at least 20 percent solids concentration are pressure filters, vacuum filters, and scroll centrifuges. Vacuum filters and centrifuges produce solids concentrations of about 20 to 30 percent, while pressure filters consistently produce concentrations of 40 to 50 percent.

The studies at the four plants showed that no single system could economically dewater dilute alum sludge to the minimum acceptable concentration for landfill disposal. Several alternatives were investigated at each plant, and it was concluded that separation of the solids from alum sludge is best accomplished in a two-stage system:

1. Primary thickening - A gravity liquid-solids separation to achieve a solids concentration compatible with the second-stage separation (usually 2 to 6 percent total solids by weight).

2. Mechanical dewatering - A further liquid-solids separation to achieve a solids concentration compatible with the ultimate intended disposal of the solids (usually 20 percent or more total solids by weight).

A typical two-stage alum sludge de-watering process is shown schematically in this report. This is a closed system with no wastewater discharge from the plant. Filter backwash is fed into a surge tank where, after complete or partial liquid-solids separation, the liquid portion is recycled back to the raw water supply for the plant. At any particular treatment plant, studies to determine the suitability of this liquid portion for recycle are necessary. The underflow containing most of the solids is mixed with the waste stream from the settling basins. The mixed stream, generally containing less than 0.5 percent solids, is fed at nearly a constant rate to a gravity thickening system.

Concentration of solids to 2 to 6 percent is accomplished in the thickener before mechanical dewatering. The concentration achieved in the thickener has a significant effect on the economics of the mechanical dewatering system. In some systems, it may be feasible to include a secondary thickening step, such as a centrifuge, ahead of the mechanical dewatering system in order to achieve a solids concentration up to 12 percent.

From these studies, it may be concluded that treatment and disposal of water treatment plant wastes in a two-stage system are feasible. Therefore, the practice of discharging such wastes as pollutants may be eliminated.

Guarino, A.M., J.B. Pritchard, J.B. Anderson, and D.P. Rall.

Tissue Distribution of Carbon-14 Labelled DDT in the Lobster After Administration via Intravascular or Oral Routes or After Exposure from Ambient Sea Water.

Toxicology and Applied Pharmacology. 29(2):277-288. August 1974.

Key Words: DDT, shellfish.

Abstract:

A pharmacokinetic approach to studying the fate and distribution of [^{14}C] DDT was employed using the lobster, a species of obvious economic importance. The radioactive pesticide was administered by 3 different routes; intravascular, oral and by exposure from the ambient water. After intravascular administration there was very rapid removal of [^{14}C] DDT from the plasma accompanied by a strikingly persistent increase in the amount of radioactivity in the hepatopancreas. Most (>90%) of the radioactivity in this organ was shown by TLC to be the parent pesticide. Seven days after injection of [^{14}C] DDT approximately 90% of the administered radioactivity was found in the hepatopancreas and the concentrations in this organ decreased with a $t_{½}$ of 46 days. One month after treatment with 0.1 mg/kg of [^{14}C] DDT, the only other organs which contained more than 1% of the administered dose were egg masses and muscle. When the pesticide was administered to the lobster from ambient water or from food, the hepatopancreatic compartment again dominated, with more than 90% of the absorbed dose occurring in this organ 7 days after treatment. Studies conducted of residue levels in untreated lobsters indicated that the egg masses contained the largest concentration of total DDT metabolites (1 ppm). The hepatopancreas contained about 0.4 ppm while the carcass (muscle) contained about 0.1 ppm. These distribution studies suggest that while the lobster may protect itself from DDT toxicity by sequestering the pesticide in the hepatopancreas and in egg masses, bioconcentration in these tissues could be hazardous to species consuming these parts of the lobster.

Gulledge, J.H. and J.T. O'Connor.

Removal of Arsenic (V) from Water by Adsorption on Aluminum and Ferric Hydroxides.

JAWWA. 65(8):548-552. August 1973.

Key Words: arsenic, adsorption/ion exchange, effluent characteristics, livestock.

Abstract:

A study of the removal of arsenic (V) from water by adsorption on aluminum and ferric hydroxides was undertaken to simulate the removal of arsenic (V) by conventional water-treatment processes. To follow this removal, a radioactive isotope, AS^{74}, added in the form of sodium arsenate, Na_2HAsO_4, was used as a tracer. A carrier solution of sodium arsenate was added to bring the arsenic concentration in the test solutions to the USPHS limit of 0.05 mg/l. The conventional watertreatment practices simulated in the study included coagulation with aluminum or ferric sulfate, rapid mix, slow mix, sedimentation, and filtration.

The use of conventional watertreatment practices as simulated in jar-test studies shows a substantial removal of the arsenic (V). The removal of the arsenic (V) was accomplished by the adsorption of the arsenic (V) on aluminum and ferric hydroxide.

The main variables affecting the adsorption process as determined in this experiment were the pH and coagulant dosage. With increasing coagulant dosage there was a constant consistent increase in the removal of arsenic (V) at all pH levels. It appears that the pH became important because of the change in the ionic form of the arsenic (V).

Gyllenberg, H., S. Niemelä, and T. Sormunen.

Survival of Bifid Bacteria in Water as Compared with that of Coliform Bacteria and Enterococci.

Applied Microbiology. 8:20-22. 1960.

Key Words: bacteria, surface water (fresh).

Abstract:

In this article, various bacteria of intestinal origin were compared with regard to their survival in water under different conditions, and the data thus acquired may provide information for the evaluation of the suitability of Laclobacillus bifidus as an indicator of fecal pollution in water. Bifid bacteria occur in the feces of man in much greater numbers (10 x to 100 x) than coliform bacteria or enterococci.

Hager, D.G. and P.B. Reilly.

Clarification-Adsorption in the Treatment of Municipal and Industrial Wastewater.

JWPCF. 42(5):794-800. May 1970.

Key Words: BOD, total dissolved solids, adsorption/ion exchange.

Abstract:

This paper discusses the uses of activated carbon in municipal wastewater systems.

Hager, D.G. and M.E. Flentje.

Removal of Organic Contaminants by Granular-Carbon Filtration.

JAWWA. 57(11):1440-1450. November 1965.

Key Words: dieldrin, synthetic/organics, adsorption/ion exchange.

Abstract:

Granular-activated-carbon adsorption is a reliable and effective means of removing most organic impurities found in potable water supplies. Plant operations and pilot column studies have shown carbon filtration to be an effective process for removing detergents, insecticides, viruses, specific chemical pollutants, and taste and odor pollutants. These results confirm postulations that carbon bed filtration would remove a high percentage of undesirable organic contaminants from water efficiently over a wide range of impurity concentration conditions.

Hahne, H.C.H. and W. Kroontje.

Significance of pH and Chloride Concentration on Behaviour of Heavy Metal Pollutants: Mercury (II), Cadmium (II), Zinc (II), and Lead (II).

Journal of Environmental Quality. 2:444-450. October 1973.

Key Words: mercury, cadmium, zinc, lead, surface water (fresh), surface water (marine).

Abstract:
Calculations were performed (1) to assess the degree to which Hg (II), Cd (II), Zn (II), and Pb (II) complex with hydroxyl and chloride ions and (2) to evaluate the significance of such complexation in natural systems. Results indicate that both the hydroxy and chloride complexes may contribute to the mobilization of these heavy metal ions in the environment.

Hajek, B.F.

Chemical Interactions of Wastewater in a Soil Environment.

JWPCF. 41(10):1775-1786. October 1969.

Key words: ponding/land application.

Abstract:
The effects of wastewater disposal to soil will be scrutinized increasingly to predict the assimilative capacity of soil. One phase of wastewater disposal to soil, that of chemically contaminated wastewater, has been discussed to acquaint environmental engineers and scientists with experimental methods presently available for making such a prediction. These methods are summarized below:

1. Wastewater chemical characterization:
    - (a) pH,
    - (b) pollutant form and concentration,
    - (c) complimentary or accompanying ion concentrations,
    - (d) disposal variations and temperature.
2. Soil characterization:
    - (a) physical,
    - (b) mineralogical and chemical.
3. Chemical interactions of soil waste systems:
    - (a) laboratory studies,
        - i. equilibrium techniques, and
        - ii. soil column techniques.
    - (b) field prediction,
        - i. dynamic column analysis, and
        - ii. hydrodynamic disperson analysis.

Hall, H.E. and G.H. Hauser.

Examination of Feces from Food Handlers for Salmonellae, Enteropathogenic _Escherichia coli_, and _Clostridum Perfringens_.

Applied Microbiology. 14(6):928-932. November 1966.

Key Words: salmonella, shigella, _Escherichia coli_, epidemiology.

Abstract:

Duplicate fecal specimens from food handlers were collected in Louisiana. One set of specimens was examined immediately for salmonellae and shigellae by the Central Laboratory of the Louisiana State Board of Health in New Orleans; the other set was shipped to the Food Microbiology Unit at the Robert A. Taft Sanitary Engineering Center in Cincinnati, Ohio, where it was examined for enteropathogenic _Escherichia coli_ (EEC) and _Clostridum perfringens_. A total of 219 specimens were examined by both laboratories. None yielded _E. coli_; and 14 (6.4%) yielded EEC. The 14 isolates of EEC were distributed among eight serotypes; one speciman yielded two serotypes. Multiple isolations of _C. perfringens_ strains (two to four) were made from 64 (37.4%) of the specimens, and a total of 244 strains were isolated and studied for identifying characteristics. Of the total, only 87 (35.5%) could be identified serologically by a battery of 67 antisera; only 4 (1.6%) possessed the characteristics of the English "food-poisoning type." The hemolytic activity on agar containing horse, ox, or sheep blood showed that 140 (57.1%) were "hemolytic," 81 (33.1%) were "nonhemolytic," and 23 (9.8%) gave varied results. Only 12 (4.9%) of the strains produced spores that resisted boiling for 30 min. or more.

Hallock, R.J. and C.D. Ziebell.

Feasibility of a Sport Fishery in Tertiary Treated Wastewater.

JWPCF. 42(9):1656-1665. September 1970.

Key words: phosphates, fish

Abstract:

This study represents an effort to test the feasibility of a sport fishery in a unique but reproducible environment, tertiary treated domestic wastewater. The findings were generally optimistic.

1. Primary and benthic productivity were outstandingly high when compared to that of natural waters. A short efficient food chain existed.

2. Fish growth and net fish production were exceptional. In this country, the only comparable yields known to the authors involve supplemental feeding.

3. Both channel catfish and tilapia were successful. With improved water quality, they should be capable of supporting an intensive fishery in this area.

4. Rainbow trout were unsuccessful in the waters provided, but they could be considered in the future with more stringent water quality control. Phosphate removal is the key to successful fisheries of this type. Limiting phospate concentrations to sufficiently low levels will curtail primary productivity and help insure the stable oxygen conditions necessary for fish survival.

6. With proper management, reclaimed wastewater should help meet projected demands for sport fisheries near urban centers.

Halvorsen, G.A.

Movement of Elemental Constituents in Sagehill Loamy Sand Treated with Municipal Waste.

Master's Thesis, Oregon State University, Corvallis, 1975. 222p.

Key Words: iron, manganese, copper, zinc, beryllium, phosphates, ammonia, nitrates, agriculture, groundwater.

Abstract:

Shredded metropolitan waste and sludge were applied to plots in a field study and to laboratory lysimeters. Concentration of Na, K, Ca, Mg, Fe, Mn, Cu, Zn, B, P, and organic N were measured throughout the columns and in leachate. Unless strong reducing conditions appeared in the profile, NO_3-N was the only ion studied which posed an apparent threat to groundwater quality.

Hamelink, J.L. and R.C. Waybrant

Factors Controlling the Dynamics of Non-Ionic Synthetic Organic Chemicals in Aquatic Environments.

Purdue University, Lafayette, Ind., Water Research Center, December 1973. 76p. (Available from National Technical Information Service (NTIS) as PB-232 267).

Key Words: DDE, surface water (fresh).

Abstract:

The distribution and peristence of DDE and lindane added to the epilimnion of a thermally stratified, ultra-oligotrophic flooded limestone quarry were studied. The quarry was treated with a single sub-lethal dose of each compound at a concentration of 200 pptr in the epilimnion or 50 pptr based on the entire water mass. An adjacent quarry was used as a control. Water, bottom sediments, limestone rock slabs, zooplankton, and fish were periodically analyzed. Dissolved oxygen and temperature profiles were also monitored. Results indicated that persistence of the pesticides may be primarily controlled by adsorption onto suspended particles.

Hamilton, C.E.

Organic Contaminants of Water.

ASTM Standardization News. 4(1):34-36. January 1976.

Key Words: synthetic/organics, drinking and recreational water.

Abstract:

The methodology discussed is not applicable to this report except that it indicates what organics may be present in water.

Hammer, M.J.

Water and Waste-Water Technology.

Wiley, New York. 1975. 502p.

Key Words: gravity separators, activated sludge, trickling filters, aerated lagoons, anaerobic lagoons, nitification/denitrification, filtration, chemical treatment, adsorption/ion exchange, ponding/land application, chlorination, ozonation, gravity thickeners, centrifugal thickeners, vacuum filters, drying beds, pressure filtration, anaerobic digestion, aerobic digestion, heat treatment, lime treatment, composting.

Abstract:

This book provides background on various unit processes, dealing with water and wastewater technology.

Hammond, L.C.

Processed Sewage Sludge as a Fertilizer in Florida.

Soil and Crop Society of Florida. Proceedings. 33:185-187. November 27-29, 1973.

Key Words: aluminum, boron, cadmium, chromium, cobalt, copper, iron, manganese, nickel, selenium, tin, zinc, nitrates, phosphates, surface water (fresh).

Abstract:

Processed sewage sludge has been handled largely as a waste product in the U.S. with disposal by incineration or dumping in sanitary landfills or in the ocean. Some has been heat-dried for use as a fertilizer either alone or in mixed goods. In a study of processed sewage sludge use in Florida, it was found that the heat-dried product was imported in quantities equal to about 2.6% of the N fertilizer used. Further, no heat-dried sludge has been produced in Florida. Review of studies in other parts of the U.S. showed that liquid digested sludge from local sources could be applied successfully to croplands, rather than being wasted in disposal methods which may not be acceptable from a pollution standpoint.

Hammond, L.C. and R.S. Mansell.

Soil Hydraulics and Waste Water Renovation.

Department of Soil Science, University of Florida, May-June 1972.

Key Words: BOD, phosphates, nitrates, surface water (fresh).

Abstract:

This paper discusses inexpensive methods to dispose of large volumes of secondary municipal sewage effluents without detrimental pollution of surface water.

Hamoda, H.F., K.T. Brodersen, and S. Sourirajan.

Organics Removal by Low-Pressure Reverse Osmosis.

JWPCF. 45(10): 2146-2154. October 1973.

Key Words: total organic carbon, COD, total dissolved solids, ammonia, nitrates, phosphates, effluent characteristics.

Abstract:

The practical demonstration of the applicability of reverse osmosis process to wastewater treatment was undertaken using the six films considered throughout this work and the chlorinated primary-treated municipal wastewater feed. The results obtained showed that greater than 96 percent separation of organics (measured as TOC and COD) could be obtained by the reverse osmosis treatment of these wastewaters using Batch 316-type membranes under the operating conditions stated. This illustrates the capability of the type of membranes used for efficient removal of organics. The agreement of the above results with those obtained with the single organic compounds solutions indicates that the presence of some organic compounds other than those considered in this study, which might not be highly separated by reverse osmosis process, would not significantly affect the overall efficiency of organic removal.

Hance, R.J.

Soil Organic Matter and the Adsorption and Decomposition of the Herbicides Atrazine and Linuron

Soil Biology and Biochemistry. 6(1):39-42. January 1974.

Key words: herbicides, agriculture, ponding/land application.

Abstract:

Soil was subjected to a variety of treatments so as to provide a series of materials with different organic residues. These preparations were inoculated with an aqueous extract of untreated soil, then incubated at 20C° with atrazine or linuron and rates of herbicide degradation were followed. The rates were lowest when virtually all the organic matter had been removed by peroxidation. The most rapid breakdown occurred in samples which had been successively extracted with ethanol + toluene, hot water, dilute acid and dilute alkali. It is suggested that the organic residue left after this sequence contained hydrolysed materials that were easily metabolized and hence could support the most active microbial population. There was no relationship between extent of adsorption and decomposition rate.

Hannan, P.J., P.E. Wilkniss, C. Patoiullet, and R.A. Carr.

Measurements of Mercury Sorption by Algae.

Naval Research Laboratory, Washington,D.C., December 1973. 32p. (Available from National Technical Information Service (NTIS) as AD-774 694).

Key Words: mercury, fish.

Abstract:

The report describes the results of laboratory experiments concerning mercury sorption by two marine algae, Phaeodactylum tricornutum and Chaetoceros galvestonesis. Measurements of mercury uptake have been made with the use of isotopes (carried-free 197 Hg, and 203 Hg incorporated in mg mercury/liter concentrations). Significant mercury concentrations were found in cells grown in media prepared from chemically pure reagents; concentrations of 14 to 116 mg/kg were present in cells harvested from 10% and 100% concentrations of culture medium. Phaeodactylum cells grown in a 10% culture medium in the presence of 0.05 mg mercury/liter contained 2400 mg mercury/kg but their growth was inhibited only 55% in a 4-day period. Chaetoceros cells had a greater affinity for mercury and contained over 7400 mg mercury/kg when cultured for the same time period in a 25% culture medium containing 0.10 mg mercury/liter. They had not grown, as determined by fluorescence analysis.

Hansen, D.J., P.R. Parrish, and J. Forester.

Aroclor 1016: Toxicity to and Uptake by Estuarine Animals.

Environmental Research. 7:363-373. June 1974.

Key Words: chlorinated hydrocarbons, shellfish.

Abstract:

Bioassays were conducted to determine the acute toxicities of the polychlorinated biphenyl (PCB) Aroclor 1016 in flowing sea water to American oysters (*Crassostrea virginica*), brown shrimp (*Penaeus aztecus*), grass shrimp (*Palaemonetes pugio*), and pinfish (*Lagodon rhomboides*), and to determine its chronic toxicity to, and uptake and retention by pinfish. Acute 96-hour EC50's or LC50's were: oysters, 10.2 µ/liter; brown shrimp, 10.5 µg/liter; grass shrimp, 12.5 µg/liter. The PCB was not toxic to pinfish at 100 µg/liter for 96 hours, but significant mortality occurred when pinfish were exposed to 32 ug/liter of Aroclor 1016 for 42 days. Pinfish exposed to 1 ug/liter for 56 days accumulated the chemical with maximum concentrations attained in whole-fish by 21 to 28 days. Maximum whole-body residue (net weight) was 17,000 x the nominal concentration in test water. Tissue alterations, such as severe vacuolation in the pancreatic exocrine tissue surrounding the portal veins, occurred in pinfish exposed to 32 µg/liter of Aroclor 1016 for 42 days.

Haque, K. and V.H. Freed.

Behavior of Pesticides in the Environment: "Environmental Chemodynamics".

Residue Reviews. 52:89-116. 1974.

Key Words: pesticides, surface water (fresh), shellfish, air.

Abstract:

This review describes the important factors responsible for the behavior of pesticides in air, water, soils, and biota. Emphasis was given to the importance of some of the physico-chemical properties of pesticides such as water solubility, enthalpy of solution, vapor pressure, heat of vaporization, kinetics and thermodynamics of adsorption, leaching, diffusion, photochemical decomposition, microbial decomposition, chemical decomposition, and partitioning of chemicals in biopolymers in describing pesticide behavior in the environment. These physical-chemical parameters may be used to describe the persistence as well as the overall environmental impact of a chemical.

Hardisty, M.W., S. Kartar, and M. Sainsbury.

Dietary Habits and Heavy Metal Concentrations in Fish from the Severn Estuary and Bristol Channel.

Marine Pollution Bulletin. 5(4):61-63. April 1974.

Key Words: zinc, cadmium, lead, fish, shellfish.

Abstract:

Until more is known of the biology of the flounder in the area of the Bristol Channel and the estuary, particularly in relation to time of spawning and the movements of populations to and from the estuarine regions, it is impossible to do more than speculate as to the factors which may be responsible for the marked differences in body size between the populations from the North Devon coast and those of the middle estuary. However, in view of the similarities in growth rates beyond the first year or so of the life cycle, it seems unlikely that such differences could be attributed to the significantly greater concentrations of cadmium and lead in the tissues of the Oldbury flounders, although it is possible that conditions for the growth of the young of the year could be much less favorable within the estuarine region.

The observations that have been made on the relation between diet and lead and cadmium concentrations in several teleost species, point to the need for much more detailed studies of the circulation of heavy metals within the estuarine ecosystem, and in particular for further studies on the heavy metal levels within the main groups of food organisms.

Harmeson, R.H.

The Nitrate Situation in Illinois.

JAWWA. 63(5):303-310. May 1971.

Key Words: nitrites, surface water (fresh).

Abstract:
Recent studies by the Illinois State Water Survey indicate that nitrate concentrations in surface waters within the state are increasing.

Harremoes, P.

Field Determination of Bacterial Disappearance in Seawater.

Water Research. 4:737-749. 1970.

Key Words: bacteria, surface water (marine).

Abstract:

The article presents two approaches to field determination of disappearance of viable, fecal bacteria after discharge with sewage into a marine environment. The first approach is based on simultaneous sampling for bacterial counting and monitoring of dilution using a conservative tracer, which is released continuously with the sewage. The second approach uses an abrupt release of tracer for determination of both dilution and residence time in the sewage field. In both cases, the disappearance rate is best determined by comparison of fluxes of bacteria and of tracer through cross-sections of the field. The approaches are exemplified with two case reports, which show that the disappearance rate can be determined to less than 10 per cent inaccuracy.

Harris, W.

Ozone Disinfection.

JAWWA. 64(3):182-183. March 1972.

Key Words: bacteria, ozonation

Abstract:
For disinfection of water, the following ozone concentrtions are used as a guide:

1. Good bacterial quality ground water, low in turbidity and mineral content: 1/2-1 mg/liter
2. Good bacterial quality surface water with ozone applied after filtration: 2-3 mg/liter
3. Poor bacterial quality surface water with ozone applied after filtration: 2.5-5 mg/liter

Harvey, R.G.

Soil Adsorption and Volatility of Dinitroaniline Herbicides.

Weed Science. 22:120-124. March 1974.

Key Words: herbicides, groundwater.

Abstract:

Studies were conducted to determine both the extent and relative strengths of adsorption of twelve dinitroaniline herbicides to a Plamo silt loam soil. Extrapolation of laboratory results to a Plamo silt loam soil under field conditions suggests that field application of .32 kg/ha of the respective herbicides might result in herbicide concentrations between 0.00062 to 0.026 ppmw in the soil solution.

Hasenclever, H.F. and R. M. Kocan.

Candida Albicans Associated with the Gastrointestinal Tract of the Common Pigeon (Columba livia).

Sabouraudia. 13:116-120. 1975.

Key Word: epidemiology.

Abstract:

Candida albicans was cultured from the upper gastrointestinal tract of 44% and from the lower alimentary tract in 6% of 50 common pigeons (Columba livia). Thirty percent of the samples of pigeon droppings collected from different locations were positive for the yeast. The colony forming units for positive samples ranged from 2×10^2-2.8×10^5 per g dry feces. The percentage of antigenic Groups A and B for the strains of C. albicans isolated was approximately the same as for strains isolated from human sources.

Hatch, M.J. and H. Wolochow.

Bacterial Survival: Consequences of the Airborne State.

In: An Introduction to Experimental Aerobiology. R.L. Dimmick and A.B. Akers, eds. Wiley, New York, 1969. pp. 267-295.

Key Word: bacteria.

Abstract:

We can summarize observations that lead us to believe that dynamic, physiological phenomena, whether directly or indirectly controlled by genetic mechanisms, are involved in survival processes of bacteria:

1. Nonlogarithmic survival curves; nonhomogeneous populations; enhanced survival rates when humidity is shifted.
2. Survival curves differ when different sampling methods or media are employed.
    a. Differences not constant as a function of age of culture, or humidity.
    b. "Best" medium not always best as a function of cell age or aerosol age.
    c. "Best" medium for uninjured cell not always best for stressed cell.
3. Frequent lack of agreement between numbers of colonies arising from one dilution compared to the number from one above or below that dilution (dissonance).
4. Frequent observation of petite colonies arising from airborne cells, a characteristic that is apparently not transmissible.
5. Differences in numbers of colonies on duplicate samples as a function of pre-incubation treatment (cooling for example).
6. Observations of occasional intervals where the apparent number of survivors increases (recuperation) as a function of aerosol age.
7. Instances where more than one maximal sensitivity to humidity occurs.

8. Influence of oxygen on the apparent reaction of airborne cells to humidity.

9. Effects of age of culture, or cultural pretreatment, on survival.

10. Differences between rates of loss of ability to support phage lysis and loss of ability to form colonies.

Any unified hypothesis for the mechanism of death of airborne bacteria must consider all of these phenomena; any unified hypothesis for a mechanism of death must show all were considered, and did not contradict the data upon which the hypothesis is built. The problem is not just an academic one, for if we know these many factors operate in the laboratory, then they must certainly operate under field conditions. In studies of survival of bacteria, one can, at present, correlate laboratory and field data only within broad limits. Perhaps the creation of new approaches to experimental design and execution are needed for both the laboratory and field.

Hathaway, S.W. and J. B. Farrell.

Thickening Characteristics of Aluminimum and Iron Primary Sewage Sludges.

In: Pretreatment and Ultimate Disposal of Wastewater Solids. Arnold Freiberger, ed. EPA-902/9-74-002, U.S. Environmental Protection Agency, New York, Region II, May 1974. pp. 197-236.

Key Words: gravity thickeners.

Abstract:

The experiments demonstrate that Al-primary and Fe-primary sludges do not gravity thicken as well as conventional primary sludges. Al- and Fe-primary sludges produced from wastewater at Lebanon, Ohio, gravity thicken to about 4-5 percent solids. Bench-scale experiments have shown that rates can be greatly improved by dilution with effluent or polymer conditioning or both. Demonstration that dilution and/or polymer conditioning improves thickening in continuously operated equipment is needed.

Air flotation is a satisfactory means for thickening Al- and Fe-primary sludges. Performance is not as good as with conventional primary sludge, but solids content of 5-8 percent can be achieved, with solids recovery in excess of 90 percent. Anionic polymer doses of 4-8 lb/ton dry solids improves performance. Poorer results are obtained at higher doses of metal to the wastewater.

Only a limited number of polymeric flocculants were examined in this study. There is good likelihood that a more comprehensive screening would uncover polymers which produce higher solids content sludges at higher thickening rates.

Preliminary filtration experiments carried out at Lebanon have shown that filtration of Al- and Fe-primary sludges can be carried out at reasonable rates, provided the sludge solids content is 4 percent or above. This solids content can be achieved by gravity or flotation thickening. Consequently, this investigation has demonstrated that Al- and Fe-primary sludges can be thickened to concentrations that make subsequent dewatering steps practicable.

Thickening rates are sufficiently high so that capital costs for equipment need not be excessive. When polymeric conditioning was needed, dose levels were not excessive, so chemical costs would be reasonable.

Hauck, A.R. and S. Sourirajan.

Performance of Porous Cellulose Acetate Membranes for the Reverse Osmosis Treatment of Hard and Waste Waters.

Environmental Science and Technology. 3(12):1269-1275. December 1969.

Key Words: BOD, nitrates, phosphates, reverse osmosis.

Abstract:

The present primary and secondary sewage treatment facilities have as their main objectives the removal of BOD and suspended solids. These treatments are not designed to remove nitrates, phosophates, or the nonbiodegradable surfactants. The removal of the latter would be the objective of tertiary sewage treatment facilities which are not in extensive use today. Reverse osmosis can effectively take the place of tertiary treatment, and sometimes both secondary and tertiary treatments, and offers an effective means of upgrading sewage water to a quality practically suitable for all water uses. Some pilot plant results of sewage water treatment by reverse osmosis have been reported; the report gives the results obtained with a typical film and a number of samples of raw sewage water obtained from the Ottawa City primary sewage treatment plant. Experiments were made at two operating pressures, 1000 and 500 p.s.i.g. with particular reference to the removal of BOD nitrates, phospate, ABS, and total dissolved solids. The performance of the membrane was found to be very good with respect to the removal of all the above contaminants. The average BOD removals were 85.8 and 80.8% at 1000 and 500 p.s.i.g., respectively. Under the conditions of the experiments made, the average separations of nitrates, ABS, and phosphates were 50.3, 93, and 99%, respectively. The average product rates were 32.7 and 18.3 gallons per day per sq. foot at 1000 and 5000 p.s.i.g., respectively. The above results indicate that the reverse osmosis process using the type of porous cellulose acetate membranes used in this work has the potentialities of becoming an economic means of renovation of wastewaters.

Haug, R.T. and P.L. McCarty.

Nitrification with Submerged Filters.

JWPCF. 44(11):2086-2102. November 1972.

Key Words: ammonia, filtration.

Abstract:

The submerged filter provides an upward flow of waste through a bed of fixed media. Nitrifying bacteria attach to the surfaces of the media, and long solids retention times are possible. Nitrification is stable at temperatures as low as 1°C. With an influent concentration of 20 mg/l NH_3-N, oxidation was about 90 percent complete with detention times of 30 min at 25°C, 60 min at 10°C, and between 90 and 120 min at 5°C. Equivalent performance was observed with recycle using preoxygenation of waste and with bubble oxygenation.

Unreasonably long detention times are required to achieve effluent NH_3-N concentrations below about 1 to 2 mg/l. Where very low NH_3-N concentrations are required, a more economical system may be nitrification with the submerged filter followed by breakpoint chlorination to remove the NH_3-N residuals.

The rate of NH_3-N oxidation and the degree of bio-film development were observed to be functions of the NH_3-N concentration. With high ammonium concentrations at the bottom of the filter, oxidation rates and biofilm development were greatest at that point, decreasing along the height of the filter. This suggests that increased efficiencies might be realized by periodically reversing the direction of flow through the filter. This would put high ammonium concentrations at both ends and tend to promote a more uniform development of biological film.

With preoxygenation of waste, influent SS together with biological solids produced within the filter can lead to clogging and short-circuiting. Periodic backflushing is required to prevent the buildup and compaction of these solids in the void spaces of the media. This problem is not encountered with bubble oxygenation because the rising bubbles keep the pore spaces free of excess solids. Nitrification in the submerged filter should produce a polished water for reclamation.

Health Information for International Travel, Including United States Yellow Fever Vaccination Centers.

Morbidity and Mortality Weekly Report Supplement. 23. U.S. Center for Disease Control, HEW. September 1974.

Key Word: epidemiology.

Abstract:

This booklet includes vaccination information, vaccination certificate requirements, and U.S. Public Health Service recommendations.

Health Information for International Travel 1975.

Morbidity and Mortality Weekly Report Supplement. 24.
U.S. Center for Disease Control, HEW. December 1975.

Key Word: epidemiology.

Abstract:
This booklet includes vaccination information, health hints for the traveler, U.S. Public Health Service recommendations, vaccination certificate requirements, and maps showing the yellow fever endemic zones.

Hecht, N.L. and D.S. Duvall.

Characterization and Utilization of Municipal and Utility Sludges and Ashes. Vol. I: Summary.

EPA-670/2-75-033a, Dayton University, Dayton, Ohio, Research Institute, May 1975. 40p. (Available from National Technical Information Service (NTIS) as PB-244 310).

Key Words: gravity thickeners, drying beds, air flotation thickeners, centrifugal thickeners, anaerobic digestion, aerobic digestion, chlorination, lime treatment, incineration, wet air oxidation, sanitary landfill, agriculture, land reclamation, groundwater, crops, surface water (fresh), surface water (marine).

Abstract:

The nature and disposal practices for municipal and utility sludges and ashes were studied. The study was primarily concerned with the sludges from municipal wastewater and water treatment plants, coal ash from power stations, and grate residue from municipal incinerators. Each of these subject areas is presented in a separate report. Volume I presents the summary for the results and conclusions developed from each of the subject areas.

Hecht, N.L., D.S. Duvall, and A.S. Rashidi.

Characterization and Utilization of Municipal and Utility Sludges and Ashes. Vol. II: Municipal Sludges.

EPA-670/2-75-033b, Dayton University, Dayton, Ohio, Research Institute, May 1975. 241p. (Available from National Technical Information Service (NTIS) as PB-244 311).

Key Words: gravity thickeners, drying beds, air flotation thickeners, centrifugal thickeners, vacuum filters, pressure filtration, anaerobic digestion, aerobic digestion, chlorination, lime treatment, heat treatment, incineration, wet air oxidation, sanitary landfill, land reclamation, surface water (fresh), surface water (marine), crops.

Abstract:

A comprehensive characterization and evaluation was performed of disposal and utilization practices for sludges from municipal wastewater and water treatment plants. The nature and quantities of the sludges are discussed. Various sludge handling and treatment techniques are detailed. There is little information on health effects.

Hee, S.S.Q., R.G. Sutherland, K.S. McKinlay, and J.G. Saha.

Factors Affecting the Volatility of DDT, Dieldrin, and Dimethylamine Salt of (2,4-dichlorophenoxy) Acetic Acid (2,4-D) from Leaf and Glass Surfaces.

Bulletin of Environmental Contamination and Toxicology. 13:284-290. March 1975.

Key Words: DDT, dieldrin, groundwater.

Abstract:

This article discusses the general effect of variables (wind, rain, and sunlight) on the mobilization of the various pesticides into the atmosphere. This paper will bear particular significance to the area of spray irrigation of sewage sludge and wastewater.

Heesen, W.C. and D.J. McDermott.

DDT and PCB in Benthic Crabs.

Southern California Coastal Waters Research Project. Annual Report. El Segundo, Calif., June 30, 1974. pp. 109-111.

Key Words: DDT, chlorinated hydrocarbons, shellfish.

Abstract:

This article discusses PCB and DDT measured in the flesh of crabs off the coast of Southern California.

Heinke, G. and J.D. Norman.

Condensed Phosphates in Lake Water and Wastewater.

Advances in Water Pollution Research. 1970 (2):III-24/1-6.

Key Words: phosphates, activated sludge, surface water (fresh).

Abstract:

Condensed phosphates from detergents are the largest contributor of phosphorus to wastewater, about twice as much as the human waste contribution in the U.S. and about equal to it in Canada. Condensed phosphates hydrolyze extensively during activated sludge treatment, with about 15% condensed phosphates remaining in the effluent. They hydrolyze in wastewater three times faster in summer than in winter. Once discharged to surface waters, hydrolysis proceeds at a much slower rate, depending on the extent of microbial activity in the surface water. Studies on the effect of pH changes show fastest rates of hydrolysis to occur at the natural pH of wastewater or lake water. Experimental data at low levels of concentration, below 15 mg/l PO_4, are best fitted by a zero-order model. A graphical presentation allows an order of magnitude prediction of rate of hydrolysis to be expected in a particular situation. Results of this work should be of value to research on phosphorus removal methods and eutrophication studies.

Henderson, C., A. Inglis, and W.L. Johnson.

Mercury Residues in Fish, 1969-1970 - National Pesticide Monitoring Program.

Pesticides Monitoring Journal. 6(3):144-159. December 1972.

Key Words: mercury, fish.

Abstract:
As part of the fish monitoring program conducted by the Bureau of Sport Fisheries and Wildlife since 1967, composite fish samples collected during the fall of 1969 and 1970 were analyzed for mercury. Three composite samples, each of a different species and consisting of 3-5 adult fish, were collected at each of 50 monitoring stations in 1969; similarly, three composite samples and in most cases a replicate sample of one of the species were collected at each of 100 stations in 1970. Stations were located on major rivers and lakes throughout the United States. Total mercury residues equal to or exceeding the sensitivity level of 0.05 ppm were found in 129 of the 145 samples in 1969 and 373 of the 393 samples in 1970. Values ranged from < 0.05 to 1.25 ppm in 1969 samples and from <0.05 to 1.80 ppm in 1970 samples. Analyses by two different laboratories of 40 selected samples from the 1970 collection gave comparable results. Analyses of 24 selected 1970 samples indicated that 90% or more of the mercury in fish was in the form of methyl mercury.

Hendricks, C.W.

Enteric Bacterial Growth Rates in River Water.

Applied Microbiology. 24(2):168-174. August 1972.

Key Words: bacteria, surface water (fresh).

Abstract:

Enteric bacteria, including stocked strains of pathogenic species and organisms naturally present in the stream, were capable of growth in a chemostat with autoclaved river water taken 750 m below a sewage outfall. Maximal specific growth rates for all organisms occurred at 30 C whereas culture generation times ranged between 33.3 and 116 hr. Of the six laboratory strains of enteric species used, *Escherichia coli* and *Enterobacter aerogenes* grew at generation times of 34.5 and 33.3 hr, respectively, while the remaining *Proteus*, *Arizona*, *Salmonella*, and *Shigella* spp. reproduced at a rate two to three times slower than the coliforms. Little or no growth occurred in the water at incubation temperatures of 20°and 5°C and death was observed for *Salmonella senftenberg* at 20°and 5°C and for *E. aerogenes* and *Proteus rettgeri* at 5°C. When enteric bacteria naturally present in the river water were employed in similar experiments, coliform bacteria demonstrated a generation time of approximately 116 hr, whereas fecal coliforms failed to grow. Growth of the bacteria from the river demonstrated a periodicity of approximately 100 hr which suggests that much of the growth of these organisms in the chemostat may be on the glass surfaces. This phenomenon, however, was not observed with any of the stocked enteric species. Neither the stock cultures nor the aquatic strains were capable of growth in autoclaved river water taken above the sewage outfall at the three temperatures tested.

Hendricks, T.

The Fates of Trace Metals and Particulates.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Calif., June 30, 1974. pp. 141-145.

Key Words: lead, cadmium, surface water (marine).

Abstract:

The author develops a simulation model that predicts that the sedimentation rate of effluent particles at a distance of 3 km from the sewerage outfall is about 10 to 15 times the natural rate and that approximately 20 to 50 percent of the discharged particulates will settle within 10 km of the outfall.

Hendricks, T.

A Model of the Dispersion of Wastewater Constituents.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Calif., June 30, 1975. pp. 173-177.

Key Words: total organic carbon, surface water (marine).

Abstract:
At the present time it is not possible to predict the offshore-onshore distribution of materials. Studies are underway which, if successful, will enable the proper outfall stations to be selected based on dispersion.

Hentschel, M.L. and T.L. Cox.

Effluent Water Treating at Charter International Oil Company's Houston Refinery.

AIChE Symposium Series. 69(135):151-153. 1973.

Key Words: BOD, COD, suspended solids, activated sludge.

Abstract:

Refinery wastewater was treated by a specially-constructed biological unit. Effluent quality is described.

Hepatitis Surveillance.

Center for Disease Control Report 37. U.S. Public Health Service, HEW. June 1975.

Key Words: hepatitis virus, shellfish, epidemiology.

Abstract:

This pamphlet provides summaries on hepatitis outbreaks which occurred in 1973, along with its current morbidity trends. A summary of morbidity trends in the U.S. for the 8-year period (1966-1973) and discussions of shellfish-associated hepatitis and Hepatitis B antigens are also provided.

Hepatitis Surveillance.

Center for Disease Control Report 38. U.S. Public Health Service, HEW. September 1976.

Key words: hepatitis virus, epidemiology.

Abstract:
Information concerning viral hepatitis received from state health departments, university investigations, virology laboratories, and other sources, domestic and foreign is summarized.

Heppleston, P.B. and M.C. French.

Mercury and Other Metals in British Seals.

Nature. 243:302-304. June 1974.

Key Words: cadmium, lead, mercury.

Abstract:

This article examines levels of lead and cadmium in seals. While seals are not in the food chain of most Americans, they are mammals and will exhibit similar uptake and concentration mechanisms.

Herrmann, J.E., K.D. Kostenbader, and D.O. Cliver.

Persistence of Enteroviruses in Lake Water.

Applied Microbiology. 28:895-896. November 1974.

Key Words: coxsackie virus, polio virus, surface water (marine).

Abstract:

This article discusses two enteroviruses which were inactivated more rapidly in a lake than in sterile lake water; their coat proteins were degraded and, perhaps, used by microorganisms.

Hess, G.E.

Effects of Oxygen on Aerosolized Serratia marcescens.

Applied Microbiology. 13(5):781-787. September 1965.

Key Words: bacteria, groundwater.

Abstract:

Suspensions of Serratia marcescens (ATCC strain 14041) in water were aerosolized in a rotating drum in the presence of various concentrations of oxygen. The colony-forming ability of aerosolized organisms was rapidly destroyed by contact with 0.25% or more oxygen at 40% relative humidity (RH) and 25 C, but was almost unimpaired for at least 5 hr in nitrogen containing not more than 10 ppm of oxygen. Completely hydrated organisms were insensitive to oxygen at pressures up to 100 psi for 4 hr. No loss in viability occurred in aerosols of washed cells in air at 97% RH. It is proposed that dehydration of the aerosolized cell results in sensitization to lethal effects of oxygen, but is not the primary cause of death. Mn^{++}, Co^{++}, glycerol, and thiourea enhanced the biological stability of aerosols in air. Numerous similarities between the effects of oxygen in this system and in systems using freeze-dried or irradiated organisms or cell-free enzymes support the hypothesis that closely related mechanisms are involved.

Heuer, B., B. Yaron, and Y. Birk.

Guthion Half-life in Aqueous Solutions and on Glass Surfaces.

Bulletin of Environmental Contamination and Toxicology.
11:532-537. November 1974.

Key Words: organophosphorus pesticides, surface water (fresh).

Abstract:

This article develops an equation for Guthion degradation as affected by pH and temperature:

$$t_{\frac{1}{2}} = \frac{1}{K_L}\left(\frac{G_o}{G_o/2}\right)$$

Hewes, C.G. III, H.W. Prengle, Jr., C.E. Mauk, and O.D. Sparkman.

Oxidation of Refractory Organic Materials by Ozone and Ultraviolet Light.

Houston Research Inc., Texas, November 1974. 117p. (Available from National Technical Information Service (NTIS) as AD/A-003 091).

Key Words: synthetic/organics, chlorination, ozonation.

Abstract:

An experimental study of an advanced chemical oxidation system was carried out to determine the rates of oxidation of difficult to oxidize, 'refractory,' chemical species which are not removed by conventional secondary treatment plus carbon absorption. One representative was chosen for this investigation from each of the five types of refractories in municipal wastewater: alcohol, acid, amino acid, fatty acid, and polyhydroxyl alcohol. A refractory index scale was established to provide a means of comparing the resistance to oxidation of refractory compounds. All of the refractories investigated benefited by at least an order of magnitude increase in reaction rate when UV and ozone are used over that obtained when ozone alone is used. The work proves the technical feasibility of the process concept and provides preliminary data on mass transfer, reaction rate, and ozone autodecomposition for pilot scale work.

Hickey, J.L.S. and P.C. Reist,

Health Significance of Airborne Microorganisms from Wastewater Treatment Processes. Part I: Summary of Investigations.

JWPCF. 47(12):2741-2757. December 1975.

Key Words: coliforms, bacteria, air.

Abstract:

Because of the current interest in the possible health effects from viable aerosols from wastewater, particularly from land-spraying operations, it seemed appropriate to summarize and evaluate the results of investigations to date. This review is in two parts. Part I summarizes in detail the results of field investigations and related literature on the subject. Part II evaluates these findings in terms of health significance to wastewater plant workers and others exposed to wastewater aerosols and directions for future investigations.

Hickey, J.L.S. and P.C. Reist.

Health Significance of Airborne Microorganisms from Wastewater Treatment Processes. Part II: Health Significance and Alternatives for Action.

JWPCF. 47(12):2758-2773. December 1975.

Key Words: *Escherichia coli*, coliforms, shigella, salmonella, *Staphylococcus aureus*, fecal streptococci, mycobacterium, groundwater, activated sludge, trickling filter, aerated lagoons, anaerobic digestion, aerobic digestion, drying beds, agriculture.

Abstract:

The matters described below are discussed in this report:

1. The emission and spread of viable bacterial aerosols from aerated wastewater processes to areas where plant workers and nearby residents may be located has been adequately demonstrated.

2. These aerosols contain a variety of virulent, pathogenic, bacterial genera and species in particles within the human respirable size range for both upper and lower respiratory tract deposition.

3. Present evidence does not conclusively confirm or negate the existence of a health risk from viable wastewater aerosols.

4. The demonstrated potential for human exposure to viable wastewater aerosols justifies further investigation of the health effects of the aerosols.

5. This search should emphasize examination by epidemiological studies and other means of the exposed groups with due consideration of possible immunity among chronically exposed persons.

6. Potential effects include not only bacterial and viral respiratory and intestinal diseases but also allergenic response.

7. Further environmental monitoring of wastewater processes for viable aerosol production in the absence of indicated health effects is of doubtful value, an exception being the spray land application of wastewater, for which viable aerosol evaluation is needed.

8. Concurrent development and evaluation of viable aerosol control measures in anticipation of finding health effects may be valuable.

9. Wastewater works practitioners and health professionals should be made aware of the potential hazards of viable wastewater aerosols.

10. The aeration of wastewater, wind, speed, and aerosol die-off are the primary factors shown to affect viable aerosol generation, survival, and dispersion from wastewater. The effects of other environmental factors have not yet been fully evaluated and may lack health significance.

11. For further environmental aerosol monitoring that may be needed, either to evaluate the need for aerosol control or the degree of control achieved by various measures, the development of a suitable index agent for assaying viable wastewater aerosols and the use of sampling procedures capable of distinguishing viable aerosol particle size spectra are recommended.

Hidu, H.

Effects of Synthetic Surfactants on the Larvae of Clams (*M. mercenaria*) and Oysters (*C. virginica*).

JWPCF. 57(2):262-270. February 1965.

Key Words: synthetic/organics, shellfish.

Abstract:

The results of these experiments on the effect of eight synthetic surfactive agents on clam and oyster larvae indicate the following:

1. Development of fertilized eggs and growth and survival of fully-formed veliger larvae of clams and oysters was reduced by concentrations of surfactants between 0.01 and 5.00 mg/l of active ingredient, depending on the surfactant used. The mean concentration producing such a reduction was 1.23 mg/l;

2. The cationic surfactants, lauryl pyridinium chloride (C-2) and a quarternary ammonium compound (C-1), were the most toxic. The mean of the minimum concentrations causing a significant reduction in development of fertilized eggs and survival and growth of veliger larvae was 0.30 mg/l. The range of minimum test concentrations causing these reductions was 0.01 to 1.00 mg/l;

3. The anionic surfactants, three alkyl aryl sulfonates (AAS-1, AAS-2, and AAS-3) and one alkyl sulfate (AS-1) were intermediate in toxicity. The mean minimum concentration causing a reduction in growth and survival was 1.15 mg/l and the range was 0.14 to 3.00 mg/l;

4. The nonionic surfactants, two alkyl polyether alcohols (N-1 and N-2), were least toxic. The mean minimum concentrations causing a reduction in growth and survival was 2.33 mg/l and the range was 1.00 to 5.00 mg/l;

5. Clam larvae were less sensitive to surfactants than were oyster larvae. The mean minimum concentration for all detergents required to reduce significantly growth and survival of clam larvae was 1.44 mg/l, while that for oyster larvae was 1.02 mg/l;

6. Reduction in the growth of larvae of clams and oysters occurred at lower concentrations, in most cases, than those required to produce mortality. In acute toxicity tests development of fertilized eggs was always halted at lower surfactant concentrations than those producing mortality of fully-formed veliger larvae within 48 hr; and

7. Concentrations of surfactant detrimental to clam and oyster larvae may be reached in certain commercial shellfish habitats. This study should be augmented by determination of surfactant levels encountered over shellfish beds. Bioassay methods could be used to determine possible modification of the effect of these compounds by the widely variant ecological factors found in nature.

Hileman, L.H.

Inorganic Minerals in Water...How Do They Pertain to Human Health? (Personal Communication).

Key Words: iron, copper, chromium, lead, fluorides, zinc, nitrates, nitrites, drinking and recreational water.

Abstract:

The reference system is somewhat inadequate, making the article less useful. The article reviews literature about the optimum levels and harmful levels of trace elements in the human diet, and whether the levels in drinking water cause beneficial or adverse health effects.

Hileman, L.H. and W.E. Sabbe.

Nitrate-Nitrogen in Domestic Water Supplies.

Arkansas Farm Research. 17(3). May-June 1968.

Key Words: nitrates, surface water (fresh), drinking and recreational water.

Abstract:

A survey of the NO_3-N levels in the domestic water supplies in Arkansas was begun in 1964. Only 2.2% had a NO_3-N level above 10 ppm, the maximum recommended level for human consumption.

Hill, W.F., F.E. Hamblet, and W.H. Benton.

Inactivation of Poliovirus Type I by the Kelly-Purdy
Ultraviolet Seawater Treatment Unit.

Applied Microbiology. 17:1-6. January 1969.

Key Words: polio virus, radiation treatment.

Abstract:

Three experiments were conducted to determine the effect of ultraviolet (UV) radiation on poliovirus-contaminated seawater. In two of the experiments, the effectiveness of the Kelly-Purdy UV Seawater Treatment Unit to inactivage poliovirus type 1 (T_1) suspended in continuously flowing seawater was determined. In experiment 1, the observed survival ratio of poliovirus T_1 was 2.3×10^{-4} (99.98% reduction) in 15.7 sec. No virus was detected (< 0.2 plaque-forming unit/ml) in 20.6 seconds. The calculated half-life value was 1.29 sec. In experiment 2, the observed survival ratio of poliovirus T_1 was 5.9×10^{-4} (99.94% reduction) in 11.7 sec. No virus was detected in 15.7 sec. The calculated half-life value was 1.37 sec. In experiment 3, a laboratory-controlled UV experiment designed to closely simulate the geometry of the continuously flowing seawater system, the observed survival ratios of poliovirus T_1 were 9.7×10^{-3} (99.03% reduction) and 3.6×10^{-4} (99.96% reduction) in 15 and 30 sec, respectively; the calculated half-life value was 2.38 sec. A statistically significant difference was found between the inactivation rates of poliovirus T_1 in the two test systems. This rate difference was attributed primarily to UV dosage and stirring effects. The data indicated that UV radiation effectively inactivated poliovirus T_1 in flowing seawater. These results validate the efficacy of the Kelly-Purdy UV Seawater Treatment Unit for use in commercial depuration systems.

Hill, W.F., Jr., F.E. Hamblet, W.H. Benton, and E.W. Akin.

Ultraviolet Devitalization of Eight Selected Enteric Viruses in Estuarine Water.

Applied Microbiology. 19:805-812. May 1970.

Key Words: polio virus, ECHO virus, coxsackie virus, radiation treatment.

Abstract:

The effect of ultraviolet (UV) radiation on the devitalization of eight selected enteric viruses suspended in estuarine water was determined. The surviving fractions of each virus were calculated and then plotted against the UV exposure time for purposes of comparison. Analytical assessment of the survival data for each virus consisted of least squares regression analysis for determination of intercepts and slope functions. All data were examined for statistical significance. When the slope function of each virus was compared against the slope function of polio virus type 1, the analytical findings indicated that polio virus types 2 and 3, ECHO virus types 1 and 11, and Coxsackie virus A-9 exhibited similar devitalization characteristics in that no statistically significant difference was found ($P > 0.05$). Conversely, the devitalization characteristics of Coxsackie virus B-1 and reovirus type 1 were dissimilar from those of poliovirus type 1 in that a statistically significant difference was found between the slope functions ($p < 0.05$). This observed difference in devitalization of Coxsackie virus B-1 and reovirus type 1 was attributed primarily to the frequency distribution of single and aggregate virions, the geometric configuration, the size of the aggregates, and the severity of aggregation. The devitalization curve of Coxsackie virus B-1 was characteristic of a retardant die-away curve. The devitalization curve of reovirus type 1 was characteristic of a multihit-type curve. The calculated devitalization half-life values for poliovirus types 1, 2, and 3; ECHO virus types 1 and 11; Coxsackie types A-9 and B-1; and reovirus type 1 were 2.8, 3.1, 2.7, 2.8, 3.2, 3.1, 4.0, 4.0 sec, respectively. These basic data should facilitate an operative extrapolation of the findings to the applied situation. It was concluded that UV can be highly effective and provide a reliable safety factor in treating estuarine water.

Hill, W.F., Jr., E.W. Akin, W.H. Benton, and F.E. Hamblet.

Viral Disinfection of Estuarine Waters.

Journal of the Sanitary Engineering Division, ASCE.
97(SA5):601-615. October 1971.

Key Words: polio virus, ECHO virus, coxsackie virus, radiation treatment.

Abstract:

Ultraviolet (UV) radiation is presently the treatment of choice for disinfecting seawater for shellfish depuration systems. The ability of UV to disinfect virus-contaminated seawater had not been previously tested. Consequently, experiments were undertaken to determine the effect of UV on virus-contaminated seawater under static and continuously flowing conditions. In the static UV experiments, the effect of UV on the devitalization characteristics of eight selected enteric viruses suspended in seawater under unstirred conditions was determined. In the flowing seawater UV experiments, the effectiveness of the Kelly-Purdy UV Seawater Treatment Unit to devitalize poliovirus type 1 (vaccine strain) suspended in continuously flowing seawater was determined.

Under the static seawater conditions (lab-control UV experiments), the devitalization characteristics (slope) of each virus was compared against that of polio virus type 1. The analytical findings indicated that polio virus types 2 and 3, ECHO virus types 1 and 11, and Coxsackie virus A-9 exhibited similar devitalization characteristics to polio virus type 1 in that no statistically significant difference was found between the slope functions ($P > 0.05$). Conversely, a statistically significant difference was found ($P < 0.05$) between the slope functions of polio virus type 1 and those of Coxsackie virus B-1 and reovirus type 1. This observed difference in devitalization of Coxsackie virus B-1 and reovirus type 1 was attributed primarily to the frequency distribution of single and aggregate virions. The devitalization curves of the enteroviruses were characteristic of retardant die-away curves. The devitalization curve of reovirus type 1 was characteristic of a multihit-type curve. The loss of infectivity of all the viruses examined was 99% or greater after 30 sec of UV exposure to 116 ergs per sq mm per sec.

Under the continuously flowing seawater conditions (Kelly-Purdy UV experiments), the analytical findings indicated

that the devitalization rate of polio virus type 1 was significantly different ($P < 0.05$) than the devitalization rate of the same virus under the conditions of the lab-control UV experiments. The most noticeable difference was the fact that the exponential rate of devitalization was significantly increased (steeper slope function) in the flowing seawater system. This difference was attributed primarily to UV dosage and stirring effects. The loss of infectivity of polio virus type 1 exceeded 99.9% after 15.7 sec of UV exposure in the Kelly-Purdy UV Seawater Treatment Unit. Based on the findings herein, it could be expected that the percent reduction times of the viruses studied under static conditions would be considerably reduced under the continuously flowing conditions. This would provide then an added safety factor in the actual effectiveness of the prototype UV treatment unit to disinfect virus-contaminated seawater when effective exposure time is based on static studies. Therefore, based on the data reported herein, it is advanced that UV radiation can be highly effective and if properly applied it will provide a reliable safety factor in disinfecting (treating) flowing seawater for use in artificial shellfish purification systems.

Hiltbold, A.E., B.F. Hajek, G.A. Buchanan, and C.E. Scarsbrook.

Leaching of Picloram and Nitrate in Two Alabama Soils.

Auburn University, Alabama, Dept. of Agronomy and Soils,
July 1974. 21p. (Available from National Technical
Information Service (NTIS) as PB-236 856),

Key Words: nitrates, ponding/land application , land reclamation.

Abstract:
The following observations were made:

1. Nitrate moved downward in Dothan loamy sand and in Hartsells fine sandy loam at the rate of about 1 inch per 1 inch of rainfall received.

2. Some picloram was retained in surface soil whereas all nitrates were eventually leached below the surface soil.

3. The picloram that was leached below the surface soil moved downward at about the same rate as nitrate.

4. The rates of leaching 200- and 800-lb N/A applications are essentially equal.

5. A mathematical model of nitrate leaching was developed that fit the observed leaching in these soils within the range of field sampling precision.

Hindin, E. and P.J. Bennett.

Transport of Organic Insecticides to the Aquatic Environment.

Advances in Water Pollution Research. 1970(2):III-19/1-16.

Key Words: chlorinated hydrocarbons, DDE, DDD, surface water (fresh).

Abstract:

This study has verified the observation made by others, i.e., that persistent insecticides, such as DDT residing in the soil, can be carried over in the soil from one growing season to the next. This quantity is greatly diminished over the quantity found in the soil immediately after application. As a result of this carryover, once an area has received insecticide treatment, the more persistent chlorinated hydrocarbon insecticides will be present for an indefinite number of years. This conclusion is based on observations reported herein and that of Taschenberg et al., and the work of Rodenheser.

Inconclusive evidence was found concerning the carryover of ethion - an organic phosphorus insecticide - in the soil. This investigation found that trace quantities (about 5 milligrams of ethion per cubic meter of soil core) may be carried over from one season to the next. However, the evidence is not as conclusive as that found for DDT.

The chemical characteristics of the water that drains land surfaces are influenced by the type, form, and quantity of substances residing on the soil surface, in addition to the physical character of the soil. Surface drainage - in this case irrigation runoff water - has the ability to dissolve and/or carry in suspension insecticides and to carry silt particles on which insecticides are adsorbed. It can be expected that the insecticides and their metabolites will be transported from the once-treated area to a natural body of water as long as there are insecticides still residing in the soil of the drainage area.

The exact quantity of insecticides (and their metabolites) carried off by the drainage water at any one time should be determinable if the quantity of the insecticide residue in the soil is known. This relationship is not a simple proportionality, mathematically. Rather such factors enter into the relationship as rate of solution or de-adsorption of the insecticide from the soil by the water, quantity of insecticide-bearing colloidal silt, and re-adsorption of the insecticide by the soil particles re-

maining on the land surface. All these variables are in turn dependent on the rate of surface water runoff, compactness of the soil, the number of times runoff has occurred after application, and the ability of water molecules to displace insecticides in or on the soil matrix. It was outside the realm of this study to investigate these variables in detail. Rather the purpose was to establish an experimental plan with procedures to determine which variables must be investigated to construct such a model.

The quantity of insecticides and their metabolites transported away via the surface drainage and water-borne settleable silt was extremely small compared to the amount of each insecticide and their metabolites residing in the soil. However, concentrations generally at the nanogram to microgram per liter range are extremely significant owing to the ability of aquatic life inhabiting such waters to remove and concentrate the insecticides in their tissues. Thus it is of great importance if there is a sufficiently high concentration of insecticides in the settleable silt to cause the benthos organisms to contain high sublethal concentrations in their tissues, as the benthos organisms comprise an important food source for many aquatic predators.

It would be naive to think that once application of the persistent chlorinated organic insecticides to a land area ceases, the insecticides in the surface drainage will disappear. Rather, insecticides will be transported from the once treated area by surface drainage for many years. For DDT at the beginning of the 1970 season, the fraction left after one year's decay was 0.64 of that applied the previous season. This would correspond to a half life of about 1.8 years for DDT. In Rodenheser's study, a fraction left after six years' decay was 0.74, corresponding to a half life for DDT of about 10 years. It is believed that if this study were continued as long as Rodenheser's, the half life of DDT in the soil would be much longer. Whichever half life value for DDT is considered valid, it is apparent that DDT will remain in the soil for a long time after discontinuation of DDT application. Hence it will be in the surface drainage for many many years.

Hinesly, T.D.

Agricultural Application of Digested Sewage Sludge; Municipal Sewage Effluents for Irrigation.

_In_: Municipal Sewage Effluent for Irrigation. C.W. Wilson and F.E. Beckett, eds. Agricultural Engineering Department Symposium, Louisiana Polytechnic Institute, Ruston, La., 1968. pp. 45-48.

Key Words: zinc, chromium, copper, lead, manganese, nickel, nitrates, _Escherichia coli_, agriculture.

Abstract:

This paper is a discussion of the results of a test lysimeter program. Zn and Mn are present in greater quantities in soil treated with sewage sludge than without. Nitrate levels were also high. It was shown that _E. coli_ rapidly disappears when incubated in sludge, or autoclaved sludge. However, it persists and even grows when added to aerobic sludge. It can be inferred that the destruction of _E. coli_ is not caused by competition with another organism.

Hinesly, T.D. and B. Sosewitz.

Digested Sludge Disposal on Crop Land.

JWPCF. 41:822-830. May 1969.

Key Words: chromium, copper, lead, manganese, nickel, zinc, nitrates, agriculture.

Abstract:

While all the results are not in for the first year research and demonstration projects, some observations may be summarized as follows:

1. Using good cultural practices, all crops tested responded favorably to digested sludge, even though most applications were made late in the growing season.

2. Offensive odors from well-digested sludge applications have not been a problem.

3. Flies were never a problem, even where application rates exceeded the soil infiltration capacity.

4. From the standpoint of aesthetics, furrow irrigation is preferred over sprinkler irrigation, although no burning of crops was observed where sprinkler systems were used.

5. Digested sludge application rates which supply nitrogen in amounts greater than those needed for crop production will increase nitrate levels in drainage water. Thus, further research will be directed toward determining soil and water management practices to deplete the soil of excessive nitrogen contents by denitrification processes.

Hinesly, T.D., O.C. Braids, and J.E. Molina.

Agricultural Benefits and Environmental Changes Resulting from the Use of Digested Sewage Sludge on Field Crops.

(SW-30d) Environmental Protection Agency, Washington D.C., 1971. 62p.

Key Words: zinc, manganese, iron, cadmium, chromium, lead, ammonia, nitrates, phosphates, viruses, coliforms, bacteria, anaerobic digestion, land reclamation.

Abstract:

Included in this report is data which includes fecal coliform die-off, along with a discussion on the advantages and disadvantages of applying sludge to agricultural lands.

Hinesly, T.D., R.L. Jones, and E.L. Ziegler.

Effects on Corn by Applications of Heated Anaerobically Digested Sludge.

Compost Science. 13(4):26-30. July-August 1972.

Key Words: iron, manganese, chromium, copper, cadmium, nickel, lead, zinc, agriculture.

Abstract:

To summarize, a favorable corn yield response can be expected from relatively large sludge applications in a year of normal weather conditions. Also, yields were not decreased by sludge applications during a very wet growing season. Indeed, yields on sludge-treated plots were never lower than those obtained on control plots maintained at a high level of fertility. Trace elements added as constituents of sludge have not presented a toxicity problem detectable either by tissue analysis or pathological symptom, even though Blount silt loam is a poorly drained soil and soil pH was permitted to decrease to a low value with respect to usual standards of field crop production. Since trace elements would be most mobile or available to plants in poorly drained, acid soils, the concentrations of trace elements in corn tissue samples are higher than would be expected where internal soil drainage is better and soil pH is maintained at a value of 6 or greater. Thus, corn plants did not accumulate toxic levels of trace elements, even under soil conditions which should favor such detrimental conditions to the plant.

Hinesly, T.D., O.C. Braids, and J.E. Molina.

Hygienic Aspects of Liquid Digested Sludge Disposal on Cropped Land.

In: Agricultural Benefits and Environmental Changes Resulting from the Use of Digested Sewage Sludge on Field Crops. U.S. Environmental Protection Agency, Washington, D.C., 1971. pp. 47-53.

Key Words: *Escherichia coli*, coliforms, salmonella, anaerobic digestion, agriculture.

Abstract:

This article discusses the danger from infection that is controlled by the ability of pathogens to survive the soil-air interface.

Hinesly, T.D., O.C. Braids, and J.E. Molina.

Plant Chemistry.

In: Agricultural Benefits and Environmental Changes Resulting from the Use of Digested Sewage Sludge on Field Crops. U.S. Environmental Protection Agency, Washington, D.C., 1971. pp. 19-33.

Key Words: copper, manganese, nickel, lead, chromium, iron, agriculture.

Abstract:

This article gives pertinent data on the uptake of heavy metals by plants.

Hinesly, T.D., O.C. Braids, and J.E. Molina.

Properties of Liquid Digested Sludge with Respect to Land Disposal.

In: Agricultural Benefits and Environmental Changes Resulting from the Use of Digested Sewage Sludge on Field Crops. U.S. Environmental Protection Agency, Washington, D.C., 1971. pp.3-12.

Key Words: ammonia, nitrates, nitrites, phosphates, chromium, cadmium, copper, lead, manganese, nickel, zinc, anaerobic digestion.

Abstract:

The chemistry of liquid digested sludge is discussed as are seed germination in and volatilization of ammonia from liquid sludge. The paper also describes the effect of digested sludge application on soil atmosphere and the rate at which digested sludge dewaters after application on crop land.

Hinesly, T.D., O.C. Braids, and J.E. Molina.

South Farm Lysimeter Research.

In: Agricultural Benefits and Environmental Changes Resulting from the Use of Digested Sewage Sludge on Field Crops. U.S. Environmental Protection Agency, Washington, D.C., 1971. pp.15-18.

Key Word: agriculture.

Abstract:

This article discusses yields of farmland applied with sludge. No health effect data are included.

Hinesly, T.D., R.L. Jones, J.J. Tyler, and E.L. Ziegler.

Soybean Yield Responses and Assimilation of Zn and Cd from Sewage Sludge-Amended Soil.

JWPCF. 48(9): 2137-2151. September 1976.

Key Words: zinc, cadmium, nitrates, phosphates, agriculture, crops.

Abstract:

Soybeans were brown each year on field plots irrigated annually with three rates of digested sludge. Applications of digested sludge significantly increased soil levels of Zn and Cd which were reflected by increased concentrations of these elements in plant tissues. However, there were no indications that the absorption and translocation of relatively large amounts of Zn and Cd into leaf and petiole and into seeds had caused a phytotoxic condition. Only the large amounts of P applied as a constituent of sludge on maximum sludge-treated plots caused a yield depression during one growing season. But, the P phytotoxic condition was rapidly dissipated after sludge applications were suspended and during the following growing season soybean yields were significantly higher on maximum sludge-treated plots than on fertile control plots. Thus, when sludges containing relatively high concentrations of P are applied on crop land where plants susceptible to P toxicity are grown, the P content of sludges per se may limit sludge loading rates than than sludge-borne Zn and Cd.

Considering the rate at which sludge-applied organic matter was mineralized in soil and the types of organic materials accumulated in soil as a result of sludge applications, the organic constituents of sludge provide very little protection to plants against Zn and Cd concentrations in the soil. It seems more likely that Zn and Cd ions were being rapidly incorporated into sparingly soluble compounds by inorganic precipitation reactions in the soil from several years of continuous sludge applications, it will occur during the time sludge is being applied rather than after applications have been terminated as suggested by others.

Hites, R.A. and K. Biemann.

Water Pollution: Organic Compounds in the Charles River, Boston.

Science. 178:158-160. October 13, 1972.

Key Words: synthetic/organics, surface water (fresh).

Abstract:

The major lipophilic organic compounds present in water collected during November and December 1971 from the Charles River Basin (Boston) are as follows: normal alkanes (C_{10} to C_{31}), alkyl naphthalenes, alkyl anthracenes or phenanthrenes, pyrene, fluoranthene, dibutyl phthalate, and di(2-ethylhexyl) phthalate. The concentration of the naphthalenes (determined by liquid chromatography) correlates with the effective stormwater runoff content of the river. These data suggest a multiplicity of sources ranging from indigenous biological materials to automobile exhaust condensate.

Hoadley, A.W. and S.M. Goyal.

Public Health Implications of the Application of Wastewaters to the Land.

School of Civil Engineering, Georgia Institute of Technology,
Atlanta, Georgia. 50p.

Key Words: salmonella, shigella, coxsackie virus, ECHO virus, Escherichia coli, viruses, bacteria, surface water (fresh), chlorination, ozonation.

Abstract:

In this article, factors affecting exposure of man and animals to pathogens applied to the land with wastewater and sludges have been examined.

Hoeppel, R.E.

Nitrogen Transformations in Wetland Soils.

U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss., Environmental Effects Laboratory, September 1974. 21p. (Available from National Technical Information Service (NTIS) as AD/A-000-610).

Key Words: ammonia, nitrates, nitrites, ponding/land application , agriculture.

Abstract:

Based on the literature review conducted in this study, it is concluded that:

1. Biologically mediated nitrogen transformations are of prime importance in wetland soils.

2. Reduced conditions generally favor loss of nitrogen from the soil, but these conditions also favor the biological fixation of gaseous nitrogen from the atmosphere in special situations.

3. In order for ammonium or organic nitrogen to be lost as nitrogen or nitrous oxide gas, both the presence and absence of oxygen are needed in the system. The oxidation of ammonium to nitrate is initially required in order to obtain gaseous loss via denitrification.

4. Acidic soil conditions favor loss of nitrogen, probably from the interaction of nitrogen cycle intermediates, but this loss is of secondary importance to the denitrification pathways.

5. Many biologically mediated nitrogen transformations are complex, often requiring the interactions of more than one species of organism.

6. Although nitrogen transformation pathways in different organisms may be comparable, many findings indicate that a given end product may not always result from any single pathway or identical enzyme system in either the same or different species.

7. Microbial populations are primarily responsible for the gaseous loss from or gain by the soil. However, these populations are often very much dependent on the higher plants for proper function.

8. Nitrogen reactions in the soil are highly pH-dependent.

9. Nitrogen reactions in the soil are largely controlled by its physical and chemical (nutritional) properties.

10. Nitrogen transformations in a soil system tend to be cyclical. For instance, an excessive loss of nitrogen or of a given nitrogen form would tend to favor a net gain of nitrogen or of a given nitrogen form by some other pathway.

Hollaender, A., G.E. Stapleton, and F.L. Martin.

X-Ray Sensitivity of E. Coli as Modified by Oxygen Tension.

Nature. 167:103-104. January 20, 1951.

Key Words: Escherichia coli, groundwater.

Abstract:

These experiments show, among other things, the importance of (a) oxygen tension in the suspensions, (b) the state of oxidation or reduction inside the organism during exposure to X-radiation, and (c) the possible modifying effect of the types of metabolism carried out by the organism before irradiation. Most of the results are consistent with the idea that radio-decomposition products of water are contributing toxic agents, for example, hydrogen ions, hydroxyl, HO_2, hydrogen peroxide, some of which are produced only in the presence of oxygen during irradiation. However, it is felt that not all the findings in regard to oxygen concentration can be explained on this basis, as the production of such products has been demonstrated only with pure water. We know very little of the modifications which might take place inside living cells, where there exists a very complicated medium containing enzymes and amino-acids, as well as many other organic and inorganic components.

Holm, H.W. and M.F. Cox.

Mercury in Aquatic Systems: Methylation, Oxidation-Reduction, and Bioaccumulation.

EPA/660/3-74-021, Environmental Protection Agency, Athens, Georgia, Southeast Environmental Research Laboratory, August 1974. 47p. (Available from National Technical Information Service (NTIS) as PB-229 329).

Key Words: mercury, surface water (fresh), fish.

Abstract:

The role of organisms on the fate of mercury in aquatic environments was evaluated. Objectives were to quantitate transformations of mercury in water-sediment systems, to investigate the fate of elemental mercury in microbial growth systems, and to measure the concentration of total and methylmercury in food chain organisms. In anaerobic water-sediment systems spiked with calcium acetate and mercuric chloride, elemental mercury was produced in larger quantities than methylmercury. In water-sediment systems, added elemental mercury was oxidized and deposited in the sediments where small amounts of methylmercury were formed. Six pure cultures of bacteria oxidized elemental mercury, but none formed methylmercury. In a stream receiving mercuric ion, mosquito fish contained more methylmercury than did tadpoles, snails, and aquatic insects. Algae did not contain methylmercury, even though their total mercury levels were high.

Holmes, C.W., E.A. Slade, and C.J. McLerran.

Migration and Redistribution of Zinc and Cadmium in Marine Estuarine Systems.

Environmental Science and Technology. 8:255-257. March 1974.

Key Words: cadmium, zinc, surface water (marine).

Abstract:

This is an excellent paper on the mobilization of zinc and cadmium in an estuarine system. The paper also discusses seasonal variations.

Hom, L.W.

Kinetics of Chlorine Disinfection in an Ecosystem.

Journal of the Sanitary Engineering Division, ASCE. 98(SA1): 183-193. February 1972.

Key Words: BOD, chlorination.

Abstract:

The influence, methodology, and prediciton of performance of chlorine disinfection of waste pond effluents comprising algal-bacterial systems are investigated in both pure cultures and mixed cultures from samples of actual pond effluents. Based on the results, the following conclusions may be drawn:

1. Disinfection of waste pond effluents is frequently essential to meet the usual disinfection criteria established for wastewater discharges to streams which have multiple beneficial uses and relatively high dilution.

2. The influence of chlorine treatment in samples of pond effluents indicates that selective chlorination which affects bacteria and algae differently can be achieved under controlled conditions in which indicator coliform bacterial organisms are destroyed while leaving the algae essentially intact. However, excessive chlorine results in degradation of algae, release of their cellular contents, and thereby a major increase in effluent BOD, defeating several of the purposes of the ponding process.

3. Reaction kinetics of chlorine disinfection in algal-bacterial systems is a complex m and n order reaction, which depends on reaction time, residual chlorine concentration, and number of surviving organisms for chlorine residuals from 0.25 mg per 1 to 2.0 mg per 1.

4. At chlorine doses greater than 2.0 mg per 1, residual effluent BOD increases significantly from 20 mg per 1 to a high of 129 mg per 1 at a chlorine dose of 64 mg per 1 in algal-bacterial systems. The increase in BOD was evidently caused by the presence of high concentration of algal cell contents in such effluents, as the phenomenon is not observed in other waste effluents.

5. Inasmuch as the production of BOD is opposed to the purposes of the ponding process, it is expected that the degradable organics produced would be available to

microorganisms, and thus microbial proliferation of uncontrolled and unpredictable magnitude may ensue.

6. The influence, methodology, and prediction of performance of chlorination in algal-bacterial systems development herein should lead to more rational designs for disinfection of effluents containing mixtures of unicellular algae and coliform bacteria.

Homma, A., M.D. Sobsey, C. Wallis, and J.L. Melnick.

Virus Concentration from Sewage.

Water Research. 7:945-950. 1973.

Key Words: polio virus, epidemiology.

Abstract:

Optimal conditions for concentrating poliovirus from large volumes of raw sewage were established. Solids 1 μm or larger, present in the raw sewage, were removed by textile clarifying filters without significant retention of virus. By acidification of the clarified sewage and addition of salts to enhance virus attachment to the adsorbent, virus in the sewage was concentrated on a fibre glass depth filter, with subsequent elution of virus into small volumes suitable for assay. An 80-95 percent efficiency of virus concentration was effected.

Hook, J.E., L.T. Kardos, and W.E. Sopper.

Effects of Land Disposal of Wastewaters on Soil Phosphorus Relations.

In: Conference on Recycling Treated Municipal Wastewater through Forest and Cropland. W.E. Sopper and L. Kardos, eds. EPA-660/2-74-003, Pennsylvania State University, University Park, Institute for Research on Land and Water Resources, March 1974. pp. 179-195.

Key Words: phosphate, ponding/land application, crops.

Abstract:

Soils and soil plant systems may be effectively used to renovate wastewaters. Applications must be managed so that the constituents of the wastewater remain at the disposal site or leave in harmless or beneficial forms. The water which leaves the disposal site should have concentrations below USPHS recommended limits for drinking water and below stream standards where applicable. In the case of phosphorus, a major constituent of municipal wastewaters, the soil-plant system proves to be an excellent renovating media. When the system is properly managed most of the added phosphorus remains in the soil at the disposal site or leaves as a nutrient in harvested crops. Soils differ in their ability to hold phosphorus. In a heavy textured soil high in sesquioxides, phosphorus from effluent irrigation did not increase in the soil below a depth of one foot after 7 years of irrigation. In a light textured soil with half as much sesquioxides phosphorus content of soils increased to a depth of 3 feet after 6 years of treatment. The Bray test for available phosphorus was suitable for determining zones of accumulation of added phosphorus. The fractionation of total soil phosphorus enabled a rough mass balance to be made for the phosphorus within the disposal system.

Hornor, S.G.

The Effect of a Municipal Effluent on the Microbial Populations of the Willimantic/Shetucket Rivers.

Master's Thesis, Connecticut University, Storrs, Institute of Water Resources, 1974. 128p. (Available from National Technical Information Service (NTIS) as PB-240 029).

Key Words: yeasts, bacteria, coliforms, surface water (fresh).

Abstract:

The distribution and relative numbers of bacteria, yeast, and algae in a river system in central Connecticut receiving primarily treated municipal effluent was examined over a 15 month period. With respect to selected chemical and microbial variables, including total coliform/fecal coliform ratios, the impact of the municipal effluent was minimal a short distance downstream from the study area. Rather, the single most important factor determining the annual distribution of river microflora was river flow. A high correlation was found between the yeast populations and other microbial and environmental variables, suggesting that these organisms may be significant indicators of water quality.

Horvath, R.S.

Cometabolism of the Herbicide, 2,3,6-Trichlorobenzoate by Natural Microbial Populations.

Bulletin of Environmental Contamination and Toxicology. 7(5):273-276. May 1972.

Key Words: herbicides, surface water (fresh).

Abstract:

This study states that in the absence of microbial life, oxidation of the herbicide did not occur. This study does indicate that natural microbial populations are capable of degrading pesticides.

Hovsenius, G.

Composting and Use of Compost in Sweden.

JWPCF. 47(4):741-747. April 1975.

Key Words: zinc, composting.

Abstract:
This is a very general article discussing composting in Sweden.

How Paraquat Gets into the Lung.

New Science. 64(927):791. 1974.

Key Words: herbicides, epidemiology.

Abstract:

Paraquat, a widely used bipyridyl herbicide, causes severe lung damage leading to death days or even weeks after it has been swallowed. It has been suggested that paraquat is accumulated in the lung via an energy-dependent mechanism which acts like a pump to remove paraquat from the blood plasma and store it in the lung. Once paraquat gets to the lung, the way in which it is retained is still unknown, although this also appears to be energy dependent. The major gross effect on the lung is scar formation which causes the lung to lose its respiratory efficiency. Paraquat uptake in lung slices has been inhibited by the addition to the medium of iodo-acetate and potassium cyanide (preventing glycolysis and pyruvate metabolism, respectively), or by the addition of rotenone, the specific inhibitor of mitochondrial respiration. Thus, the uptake of paraquat by the lung depends on the lung's ability to manufacture ATP. Following paraquat administration, rats were given a saline stomach wash, followed by doses of castor oil, magnesium sulfate, and bentonite, all designed to prevent the absorption of paraquat into the plasma. The rats were treated between 4 and 10 hr after herbicide administration and an 80% recovery rate was achieved at each time interval. This may be useful in cases of human paraquat poisoning. Hemoperfusion and hemdoialysis, as methods which act directly to reduce plasma paraquat concentrations, may also prove useful.

Howells, G.P., T.J. Kneips, and M. Eisenbud.

Water Quality in Industrial Areas: Profile of a River.

Environmental Science and Technology. 4(1):26-35. January 1970.

Key Words: nitrates, phosphates, cobalt, manganese, surface water (fresh), fish, shellfish.

Abstract:

It is not difficult to predict an increased use of the Hudson River for the disposal of sewage wastes, industrial effluents, and cooling water, and for augmenting existing water supplies. At the same time, the burgeoning population of the area has a need and a right to use the river for recreation. How can further development be controlled, so that the water resources can be exploited, but still provide for that refreshment of the spirit so necessary for the urban inhabitant? Changes that might be expected from increased use are:

- First, an increasing nutrient load from domestic sewage and some industrial processes,
- Second, an increasing heat load.
- Third, an increased demand for industrial and domestic water.

Our studies have made clear that potential eutrophic nuisance species of algae are present in the river, and that the shores are populated by animals indicative of sewage pollution. Yet, serious fouling and deoxygenation have so far been avoided for most of the river. From this it could be deduced that the present situation need cause no concern; however, examples of other eutrophic water bodies give us warning of the potential rapidity of changes, and should encourage effective sewage treatment and the control of nutrient sources.

Heat additions to the aquatic environment are a major concern. In the Hudson, the volume of tidal flow can be utilized to disperse such heat; at the same time, it is clear that the capacity of the river as a heat sink is severely limited during the peak summer demand by a low net flow and high ambient air temperatures. If significant overall temperature rise in the river were allowed, it is highly probable that the species composition of the fauna and flora would be unbalanced. This interacting with the high nutrient levels in the river could easily tip the balance between nuisance

conditions and the relatively healthy biological situation seen today. The effects of a temperature rise restricted to localized sites on the river have yet to be evaluated. There is a great need for more detailed hydrological and thermal studies of the river to evaluate the capacity of the Hudson to receive heat addition. There is also need for studies of species endemic to the river to determine their response, singly and together, to changes in temperatures.

The extraction of additional water for any purpose - pumped storage schemes, industrial use, or domestic use - is also of great importance, and is closely related to the other uses of the river. Almost any increased water extraction, except industrial cooling intakes, will make a volume of water unavailable at least for limited periods or limited stretches of the river. The effects of this on the present hydrological pattern in the river remain largely unknown. It seems probable, however, that the extent and duration of salt water intrusion up the river will increase. This will limit the sites for drinking water extraction and reduce the capacity for exchange of effluent discharges with the ocean which depends largely on the net fresh water flow.

How can the situation be controlled? We need more information about all aspects of the hydrology of the estuary, about the fauna and flora of the river and their response to existing and predicted conditions. We need strictly controlled use of the river for all purposes and at all levels. And, finally, we need to know how to alleviate pollution problems when they have arisen and how to channel waste materials, including heat, to other outlets.

Hsu, D.Y. and W.O. Pipes.

Aluminum Hydroxide Effects on Wastewater Treatment Processes.

JWPCF. 45(4):681-697. April 1973.

Key Words: COD, phosphates, ammonia, nitrates, nitrites, suspended solids, activated sludge, chemical treatment.

Abstract:

In the secondary treatment process it was found that the most important effect was the increase in sludge production. The treatment efficiency measured by COD removal and total phosphate removal would be improved. The compactability of bulking sludge was improved significantly with the addition of aluminum hydroxide to the mixed liquor. No effect was found on nitrification. Total gas production during anaerobic sludge digestion would be decreased by the addition of aluminum hydroxide. Sludge dewatering, either before or after digestion, was improved.

Huang, C.H., D.L. Feuerstein, and E.L. Miller.

Demonstration of a High-Rate Activated Sludge System.

EPA/670/2-75-037, Engineering-Science, Inc., Berkeley, California, March 1975. 151p. (Available from National Technical Information Service (NTIS) as PB-240 005).

Key Words: BOD, trickling filter, influent characteristics, effluent characteristics.

Abstract:

A high-rate activated sludge system was designed, constructed and operated at the City of Chino as a biological treatment system utilizing the maximum growth-rate potential of activated sludge as a means of removing organic, and possibly inorganic, materials from domestic wastewater. Operating results indicate that full-scale systems can be operated at high growth rates and high substrate loading rates with concomitant high substrate removal velocities and high quality effluent. Substrate loading rates as high as 3.6 (mg BOD)/(mg MLVSS)(day) and effluent BOD as low as 5 mg/l were achieved. A kinetic description indicated a yield coefficient of 0.92 (mg MLVSS produced)/(mg BOD removed), a decay constant of 0.027/day and a half-saturation constant of 26 (mg BOD)/l. The significance of these kinetic characteristics in process design and operational control is presented. Four solids separation systems - vibratory screens, enhanced gravity separation, dissolved air flotation and hydro-centrifugal cleaned screens - were tested for activated sludge solids separation.

Huang, C.P. and M.H. Wu.

Chromium Removal by Carbon Adsorption.

JWPCF. 47(10):2437-2446. October 1975.

Key Words: chromium, adsorption/ion exchange.

Abstract:
Data obtained from this study led to the following conclusions:

1. Maximum removal efficiency may be achieved by using both sizes of calcinated coke and operating at all levels of total chromium concentration and at low pH values ($pH < 2.0$). However, efficiency of chromium removal increases with decreasing chromium concentration. For instance, at pH 2, 100 percent of the chromium may be removed if the concentration is less than 10^{-4} M (5.2 mg/l as Cr).

2. Calcinated cokes may be economically feasible only for acidic wastewater, which requires minimum effort in pH adjustment. One great attraction of using calcinated coke for chromium-containing wastewater, or probably, other heavy metal-containing wastewater, is its low cost.

Huang, J. C.

Effect of Selected Factors on Pesticide Sorption and Desorption in the Aquatic System.

JWPCF. 43(8):1739-1748. August 1971.

Key Words: dieldrin, DDT, chlorinated hydrocarbons, surface water (marine).

Abstract:

From the results of this study, the following conclusions may be drawn:

1. At the test pH range of 6.0 to 10.0, the adsorption of dieldrin by montmorillonite was slightly increased with a decreasing pH.

2. At the normal temperature range of 10° to 30°C, the adsorption and desorption of dieldrin by the montmorillonite sediment was not significantly affected by changes in water temperature.

3. The effect of the salt (NaCl) concentration of water on the dieldrin adsorption and desorption by montmorillonite was not conclusive. Slightly more pesticide was adsorbed and retained more strongly by the clay at a salt content of 3 percent than at 0.3 or 0.03 percent; however, the same pesticide was adsorbed slightly more and retained more strongly at a salt content of 0.03 than at 0.3 percent.

4. Several representative organic pollutants such as glucose, alanine, and stearic acid were found to exert no effect at all on the rates and equilibria of the adsorptions of dieldrin, heptachlor, and DDT by montmorillonite and illite.

5. The dieldrin adsorption by montmorillonite was not influenced by the soluble organic matter contained in the filtered domestic wastewater.

Huang, J.C. and C.S. Liao.

Adsorption of Pesticides by Clay Minerals.

Journal of the Sanitary Engineering Division, ASCE. 96(SA5): 1057-1078. October 1970.

Key Words: DDT, dieldrin, chlorinated hydrocarbons, surface water (marine).

Abstract:

Because clay minerals were found to adsorb chlorinated hydrocarbon pesticides very rapidly and to have a great potential for retaining these chemicals, it may be desirable to use these clays as carriers or diluents of pesticide in agricultural application. However, before this practice can be permitted, additional studies must be carried out to determine if there is any significant reduction in the residual pesticidal bioactivities for the pesticides already adsorbed on clays. Also, certain efficient ways must be developed to prevent the pesticide-coated clay particles from being flushed into natural waters by runoff; otherwise, the gradual desorption of some pesticides, even at very slow rates, will still provide a continuous supply of toxic chemicals to the overlying water and cause serious pollution problems.

Huang, P.M. and C.P. Hwang.

Inorganic and Organic Phosphorus Distribution in Domestic and Municipal Sewage.

Water and Sewage Works. 120(6):82-83. June 1973.

Key Words: phosphates, effluent characteristics.

Abstract:
This paper discusses the various forms of phosphorus in wastewater streams.

Huckabee, J.W., C. Feldman, and Y. Talmi.

Mercury Concentrations in Fish from the Great Smoky Mountains National Park.

Analytica Chimica Acta. 70:41-47. May 1974.

Key Words: mercury, surface water (fresh).

Abstract:

This article establishes natural levels of mercury in fish.

Hudson, H.E.

High-Quality Water Production and Viral Disease.

JAWWA. 54(10):1265-1274. October 1962.

Key Words: coliforms, viruses, filtration.

Abstract:

Filtration plants operated to attain a high degree of removal of one impurity tend to accomplish high removals of other suspended materials. Examples of parallelism in removal of turbidity, manganese, microorganisms, and bacteria are cited.

Speed and simplicity make the turbidity measurement a valuable index of removal of other materials. Plants producing very clear water also tend to secure low bacterial counts accompanied by low incidence of viral disease.

The production of high-quality water requires striving toward high goals as measured by several - not just one or two - quality criteria. These criteria include filtered-water turbidity, bacteria as indicated by plate counts and by presumptive- and confirmed-coliform determinations, and thorough chlorination.

The operating data for plants treating polluted water indicate that low virus disease rates occur in cities where the water treatment operators aim to produce a superior product rather than a tolerable water.

Hueper, W.C. and W.W. Payne.

Carcinogenic Effects of Adsorbates of Raw and Finished Water Supplies.

American Journal of Clinical Pathology. 39(5):475-481. May 1963.

Key Word: epidemiology.

Abstract:

Chloroform eluates made from adsorbates of raw and finished water of a river heavily polluted with industrial chemical pollutants, when subcutaneously injected into mice, elicited the development of spindle-cell sarcomas at the site of injection. Chloroform eluates, as well as alcohol eluates of such adsorbates on activated carbon prepared from raw and finished water, when subcutaneously injected or cutaneously applied, were probably the cause of leukemia reactions in some mice. The presence of bladder papilloma in one mouse injected with a chloroform eluate of raw water points to the probable contamination of the water with chemical carcinogens acting on the bladder that were released from rubber manufacturing plants. The rapidly growing contamination of sources of supplies of drinking water with carcinogenic agents demonstrates the urgent need for comprehensive chemical, experimental, and epidemiologic investigations on water pollutants for ascertaining whether or not such exposures of the general population may represent significant environmental career hazards.

Huggett, R.J., M.E. Bender, and H.D. Slone.

Mercury in Sediments from Three Virginia Estuaries.

Chesapeake Science. 12(4):280-282. December 1971.

Key Words: mercury, surface water (marine).

Abstract:

A survey of mercury levels in sediments (<63μ) from Virginia's three main estuaries was conducted. Results indicated that the mercury was associated with the organic fraction of the bottom material. Statistical analyses showed no differences (5% significance level) within rivers with respect to distance from the mouth or between rivers.

Comparison of the estuarine levels to those of oceanic and freshwater sediments show the oceanic to be more closely related to the estuarine with respect to mercury concentrations.

Huggett, R.J., O.P. Bricker, G.R. Helz, and S.E. Sommer.

A Report on the Concentration, Distribution, and Impact of Certain Trace Metals from Sewage Treatment Plants on the Chesapeake Bay.

Chesapeake Research Consortium, Baltimore, Maryland, June 1974. 20p. (Avilable from National Technical Information Service (NTIS) as PB-240 735).

Key Words: zinc, lead, manganese, iron, copper, surface water (marine), shellfish.

Abstract:

From detailed analyses of sewage effluents for metals and utilization of existing published data from other areas in the United States, we conclude that: For the metals cadmium, copper, zinc, and lead, the supply contributed to the Chesapeake Bay by sewage treatment plants is probably within one order of magnitude of the fluvial supply. On the other hand, for manganese, iron and nickel, the supply from rivers exceeds that from waste water.

For at least one sewage treatment plant, most of the metals released by the effluent are deposited within a few miles of the outfall. Comparison of the sediment metal concentrations near the outfall with data from other areas of the bay showed that zinc, lead, chromium, cadmium and copper were one to two orders of magnitude higher in these sediments than in uncontaminated areas. Such large concentrations could have an adverse effect on the biota. This may have occurred since the bottom of this river is essentially a biological desert with a biomass of much less than 100 mg/m^2.

The oyster, Crassostrea Virginica, can concentrate metals from sewage effluent in a very short time period. Oysters were subjected to varying concentrations of sewage effluent in a controlled laboratory environment and their metal body burdens were ascertained at the end of the experiment. It was found that the magnitude of uptake varied depending on the metal in question but that in the case of zinc, for instance, levels increased from an average of 1000 ppm to 1500 ppm in only 13 days at an effluent concentrations of 0.6%. This is extremely important in light of the fact that between 1 and 2% of the fresh water entering the bay is now sewage effluent and the amounts will undoubtedly increase.

Hulka, S.C., S.R. Keen, and E.M. Davis.

Sediment Coliform Populations and Post Chlorination Behavior of Wastewater Bacteria.

Water and Sewage Works. 120(10):79-81. October 1973.

Key Words: bacteria, fecal streptococci, surface water (fresh), surface water (marine), chlorination.

Abstract:

Coliform existence in bay sediments was reported. In an extensive survey of central Texas bays, concentrations up to 17,000 MPN/100 ml were reported. Total coliform counts of up to 198,000/100 ml in bay waters far removed from any wastewater influence was also reported. Elevated fecal coliform and fecal streptococci concentrations were also recovered. Additional work conducted on resuspension of sediment borne coliforms by turbulence was carried out, also. Fecal coliform colonies failed to develop in that series. However, it cannot be stated with any degree of certainty that no fecal coliform bacteria existed in the sediment or water column under investigation.

Apparently saline waters naturally contain enough nutrient materials to support some regeneration of enterococci populations. This bacterial characteristic was demonstrated at a storage temperature of 4°C. One consideration which must be given this phenomenon is that if bacterial populations are allowed storage beyond the recommended limit for bacterial analysis, they cannot be judged to have decreased in numbers in 100 percent of the cases. It is improbable that factors could be applied to correct for die-off in transport and/or storage as no two samples and their bacterial populations react exactly the same. After-growth of typical groups of municipal wastewater bacteria in saline receiving waters was demonstrated. Coliforms, fecal coliforms and fecal streptococci increased to about 900 percent, 600 percent and 60-70 percent of their initial densities, respectively, within the first day. Similar responses were demonstrated for E. coli and Salmonella ap. These responses indicate a definite need for more rapid and precise generic identification methodology in the area of pollution surveillance. What may appear to be pollution levels of bacteria may actually represent aftergrowth from numbers far below established standards or, by the same token, may represent the naturally occurring population.

Hume, N.B. and W.F. Garber.

Marine Disposal of Digested Screened Wastewater Solids.

Advances in Water Pollution Research. 1966(3):243-262.

Key Words: coliforms, ammonia, nitrates, nitrites, phosphates, surface water (marine), effluent characteristics.

Abstract:

Circumstances inherent in the development of the Los Angeles metropolitan area have made ocean disposal of wastewater and treated solids the most logical alternative. Realizing its responsibility to the citizens in preserving all beneficial uses, the City of Los Angeles has carried on a comprehensive oceanographic program for the past 10 yr. Careful study of the substantial amounts of data obtained indicate that the public health, aesthetic, and ecological values of the receiving waters have been little affected by the discharge from a complex carefully engineered to prevent degradation of these values. The City fully intends to continue its surveillance program and is committed to engineering plant improvements as required by flow increases or changed wastewater characteristics. As levels of information and knowledge increase the areas of investigation will be modified to encompass them.

Humenick, M.J. and W.J. Kaufman.

An Integrated Biological-Chemical Process for Municipal Wastewater Treatment.

Advances in Water Pollution Research. 1970(1):I-19/1-18.

Key Words: BOD, phosphates, ammonia, chemical treatment, activated sludge.

Abstract:

The results of the investigation may be summarized in several specific conclusions:

1. Removals of BOD in excess of 90% and COD in excess of 80% may be achieved from domestic sewage in a chemically aided activated sludge process at volumetric BOD loadings of 400 to 500 lbs per day per 1000 cu ft of aeration basin capacity (0.64 to 0.80 kg BOD/day-cu m). Under these conditions of loading the residence time of the aeration basin may be reduced to 1 hour, and good performance may be expected with as little as 20 minutes of aeration.

2. Control of the settleability of activated sludge solids may be achieved by the maintenance of inorganic solids in the aeration basin at a concentration approximately equal to that of the organic solids. Nearly equally satisfactory results were obtained with both lime precipitation and alum coagulation sludges formed in a second-stage reactor and recycled to the first-stage aeration basin. Sludge volume indices of less than 100 were achieved by this method over an 8-month period of pilot plant operation. During this period, successful operation was achieved at suspended solids concentrations exceeding 9000 mg/l and it is quite likely that higher concentrations could have been used provided an adequate supply of oxygen was maintained.

3. It is probable that the chemical sludges serve more as weighting agents than flocculants in improving the separation of the active biological solids. A short investigation of several inorganic particulates demonstrated their function to be independent of surface charge and related more to the increased density imparted to the organic suspension in which they were enmeshed.

4. Kinetic description of the biological stage appeared to follow the Monod relationship. Data were represented by first-order substrate kinetics at performance levels

required for practical design. With increasing substrate concentrations, the saturation effect predicted by the kinetic model was observed for BOD data whereas a first order relationship only was obtained for performance based on COD measurements.

5. Phosphorus removals of at least 95% were demonstrated with both lime and alum additions to a second-stage precipitation-flocculation unit. It is likely that similar performance could be achieved with ferric salts.

6. The second-stage clarifier was operated as a sludge blanket unit with the overall suspended solids removal generally exceeding 95%. The effluent turbidity was generally less than 20 JTU and less than 10 for extended periods. The high pH maintained in the slurry with lime operation precluded biological activity, but even with alum at near-neutral pH this did not interfere with clarification.

The integrated biological-chemical process offers economics in the removal of phosphorus and BOD from municipal wastewaters and should be considered in the design of new facilities intended for this purpose. Lime is the chemical to be preferred in such installations because of its lower cost and the potential for its reuse. As it is most effective in removing phosphorus at high pH, it is preferably added after biological treatment. On the other hand, aluminum and iron salts may be added directly to the aeration basin thus reducing the advantages of the two-stage system. This approach is likely to be an economic one for existing biological treatment plants. However, it is doubtful that effluent clarities will equal those achieved in a two-stage process. The problem of ammonia remains to be resolved, although where economics and benefits warrant, processes currently being demonstrated may be successfully added to the system described herein.

As the objectives of wastewater treatment change, it is desirable to re-examine the treatment system as a whole seeking new processes that meet the new objective at minimum costs. Soluble organic compounds, especially those of low molecular weight, are readily assimilated by biological suspensions and are less easily separated by coagulative or sorptive reactions. On the other hand, chemical coagulants have been shown under many circumstances to be effective in removing suspended and colloidal matter. The proposed process seeks to take advantage of the properties of both biological and chemical-physical processes in an integrated system.

Hunter, J.V. and T.A. Kotalik.

Chemical and Biological Quality of Sewage Effluents.

In: Conference on Recycling Treated Municipal Wastewater through Forest and Cropland. W.E. Sopper and L. Kardos, eds. EPA-660/2-74-003, Pennsylvania State University, University Park, Institute for Research on Land and Water Resources, March 1974. pp. 6-27.

Key Words: total organic carbon, synthetic/organics, salmonella, coliforms, fecal streptococci, shigella, *Clostridium botulinium*, *Clostridium welchi*, mycobacterium, yeasts, parasitic worms, protozoa, hepatitis virus, *Escherichia coli*, activated sludge, trickling filters, chlorination, effluent characteristics.

Abstract:

The chemical and biological composition of effluents reflects the quality of the wastewater entering the plant and the changes that occur during the physical, chemical, and biological processes in the plant. The chemical changes that occur during treatment reflect the biological removal of 80-90% of the organic matter and the production of more oxidized organics. Thus, effluents will contain such materials as proteins, carbohydrates and soluble organic acids which either persist through the plant or are formed in it, such organics as Alkyl Benzene Sulfanates which have persisted through it, or such organics as Fulvic, Humic and Hyathomelanic Acids which are probably formed during treatment.

Interest in the removals of microorganisms during treatment lies mainly in the area involving the efficiency of pathogen removal. Sedimentation and biological oxidation do markedly reduce pathogens, but as removals will depend (among other things) on the concentration of the pathogen in the wastewater, their presence in the effluent from biological treatment units can be expected and demonstrated. In addition to wastewater bacteria, viruses, etc. that have persisted through the plant, large numbers of protozoa and nematodes can be developed during biological treatment. Interest here has centered on the nematodes, which can ingest pathogens and thus have public health significance.

Effluent chlorination is largely for disinfection. There is little question but that the correct combinations of time and concentration (residual) can be achieved to obtain effective disinfection. However, actual practice may not always achieve this end, and excessive chlorina-

tion without dechlorination may lead to toxicity problems in receiving waters. Although chlorine can remove nitrogen (as ammonia) from solution, it also reacts with as well as oxidizes organic materials. The significance of these chlorine containing organics in effluents has not yet been definitely established.

Hunter, J.V. and H. Heukelekian.

The Composition of Domestic Sewage Fractions.

JWPCF. 37(8):1142-1163. August 1965.

Key Words: suspended solids, total organic carbon, COD, influent characteristics.

Abstract:
The results obtained by this study indicate the following:

1. An adequate sampling and compositing procedure can give wastewaters of a truly average composition.

2. The particulate-fraction solids are approximately 80 percent organic matter, while the soluble-fraction solids are approximately 30 percent organic matter.

3. The particulate-fraction solids contained from four to seven percent organic nitrogen, while the soluble-fraction solids contained less than one percent organic nitrogen.

4. Approximately 64 percent of the total wastewater solids is contributed by the soluble fraction, but only 40 percent of the total organic matter is contributed by this fraction.

5. The particulate fractions were similar in percent volatile solids and COD, but the supracolloidal fraction had the highest percent organic nitrogen.

6. The settleable fraction usually contributed most and the colloidal fraction least to the constituent content of the total particulate solids.

7. Based on currently available data there seems to be some pattern in the general distribution of organic matter among the sewage fractions. However, there does not appear to be any notable pattern as to the distribution of nitrogenous matter.

8. Chemical coagulation did not prove to be a simple alternate method for separating wastewater fractions.

Organic Components

1. The particulate fractions were composed largely of grease (17 percent), amino acids (19 percent), and carbohydrates (21 percent). The grease was found to

be principally esterified fatty acids and unsaponifiable matter. Free fatty acids were present only in small amounts. The amino acid nitrogen content of the particulate fractions averaged only about 50 percent of the particulate organic nitrogen.

2. The organic compositions of the three particulate fractions were somewhat similar. The main difference was found in the considerably higher amino acid and hemicellulose contents of the supracolloidal fraction and the considerably higher cellulose content of the settleable solids.

3. The soluble organic matter was found to be composed largely of ethylether-extractable matter, of which the organic acids were the primary constituent (56 percent). The other organic constituents present in significant quantities were the amino acids and sugars. ABS, volatile acids, phenols, cholesterol, uric acid, and creatine-creatinine were found to be minor constituents.

4. Comparisons of some of the results obtained by this study with those already reported in the literature indicate that there is little agreement in the relative quantities of constituents of the specific groups, although the general compositions may not vary too greatly. This could be due to the analytical procedures used, or the actual composition of the sewages analyzed.

5. There was remarkably little variation in either the general character or specific composition of the wastewaters from the two collection periods. Since both collection periods included the winter months, it is difficult to assess the effect of the season on the composition of the sewage. It is doubtful, however, that this effect is too significant.

Hunter, J.V., G.R. Bell, and C.N. Henderson.

Coliform Organism Removals by Diatomite Filtration.

JAWWA. 58(9):1160-1169. September 1966.

Key Words: coliforms, filtration.

Abstract:

Most of the recent work reported on diatomite filtration of water has been concerned with either the theoretic and practical considerations of the process itself, or its use in the removal of turbidity, iron, and manganese. Thus, though the origins of diatomite filtration in the United States involved the removal of microbiologic pollutants, namely cysts of *Entamoeba histolytica*, little has been reported recently on this aspect of diatomite filtration. In view of the small particle size of the diatomite filter media, it might be expected that significant coliform organism reductions would occur following the filtration of a polluted water, and perhaps this process could yield a water that would meet the accepted coliform standards for potable water.

Investigating this possibility, preliminary work on the removal of coliform organisms in Raritan River water indicated that substantial coliform reductions could be achieved, and that this reduction could be improved by using filter aids of low permeability, or which had been coated with aluminum hydroxide. Unfortunately, interpretation of the results of this preliminary work was made difficult by the considerable and independent variations of such determining factors as turbidity and coliform organism concentrations. The results were sufficiently encouraging, however, to allow further investigation of the removal of coliform organisms under more controlled laboratory conditions.

For this purpose, a diatomite filtration unit was installed in the laboratory and used to study the factors that influence coliform removals, such as rawwater coliform level, filter aid permeability, flow rate, and body feed concentrations. In addition, the use of coated filter aids was investigated, as well as the use of small iron dosages to the raw water, by which removal of coliform organisms could be greatly improved.

Hutton, W.D. and S.A. LaRocca.

Biological Treatment of Concentrated Ammonia Wastewaters.

JWPCF. 47(5):989-997. May 1975.

Key Words: ammonia, activated sludge.

Abstract:

The design of a proposed treatment system is dictated by the results of the wastewater characterization and by laboratory and pilot plant studies.

The design aeration detention time and oxygen requirements were determined from process performance data at temperatures of 60^o to 70^o F (16^o to 21^o C) and a pH range of 7.8 to 8.4.

Design oxygen requirements were determined to be 4.7 lb O_2/day/lb NH_3-N transformed.

The SRT is very critical in achieving effective ammonia transformation. The data support the fact that the nitrifying bacteria have significantly lower growth rates than the majority of the heterotrophic bacteria associated with degradation of carbon in an organic activated sludge process. As a result, the importance of maintaining a population of bacteria of an adequate age in the aeration basin cannot be overemphasized. Process design loadings may be established if an adequate SRT is maintained, but a shift in the SRT may significantly change the design base. At the design SRT of 30 days, removal efficiencies of 85 to 90 percent are predicted.

The control of pH is very important to the nitrification process. Uncontrolled, the nitrification will reduce the alkalinity and cause the pH to drop to levels that will inhibit the process. Theoretically, one-half of the pH drop is caused by the reduction in ammonia, and the remainder results from the destruction of the natural alkalinity.

The raw wastewater alkalinities were relatively high, about 1,000 mg/l, and the pH ranged from 8.0 to 8.4. Soda ash provides more alkalinity at lower pH ranges than lime and provides an excess of inorganic carbon, which is needed for cell synthesis of the nitrifying bacteria. Based on the test results, 6.0 lb of soda ash/lb of NH_3-N transformed would be required for treatment of the wastewater that was studied.

The bacterial mass was very disperse and settled poorly. From these data, an overflow rate of 250 gpd/sq ft (10.2 cu m/day/sq m) was selected to achieve the desired settling.

For the industrial wastewater studied, having a design total ammonia concentration of 725 mg/l, a biological treatment system should achieve about a 90 percent reduction of NH_3-N and would produce an effluent quality having 75 mg/l NH_3-N, 75 mg/l NO_3-N, 575 mg/l NO_2-N, and 70 mg/l ss.

Hyde, H.C.

Sewage Sludge Utilization for Agricultural Soil Enrichment.

Presented at 7th Annual Western Regional Solid Waste Symposium, April 7-8, 1975.

Key Words: copper, zinc, nickel, cadmium, bacteria, agricultural sludge disposal.

Abstract:

This report presents the study methodology, summary of the findings, and conclusion based on a two year field study determine the feasibility of utilizing liquid digested sewage sludge for agricultural soil enrichment. Public health considerations, environmental effects, agricultural and engineering concepts and economics, and public acceptance were evaluated.

The most significant technical question was the long-term effects of heavy metals on the human food chain and the environment. The heavy metal of major concern was cadmium. Local public acceptance and regulatory requirements were the most important non-technical questions.

Hyndshaw, A.Y.

Activated Carbon to Remove Organic Contaminants from Water.

JAWWA. 64(5):309-311. May 1972.

Key Words: BOD, copper, iron, zinc, adsorption/ion exchange.

Abstract:

This article contains rather general information on carbon adsorption.

Identification of Organic Compounds in Effluents from Industrial Sources.

EPA-68-01-2926, Versar, Inc., Springfield, Va., General Technologies Division, April 1975. 211p. (Available from National Technical Information Service (NTIS) as PB-241 641).

Key Words: synthetic/organics, influent characteristics.

Abstract:

This report is an initial assessment of the possible sources of 154 organic compounds which have been identified in drinking water supplies. It lists those chemicals which may be formed by chlorination of sewage treatment or water treatment, from leachates from natural sources, and those which may be from industrial effluents.

Imhoff, K., W.J. Muller, and D.K.B. Thistlethwayte.

Disposal of Sewage and Other Water-Borne Wastes.

Ann Arbor Science Publishers, Ann Arbor, Mich., 1974. 405p.

Key Words: gravity separators, activated sludge, trickling filters, aerated lagoons, filtration, nitrification/denitrification, chemical treatment, adsorption/ion exchange, gravity thickeners, drying beds, air flotation thickeners, anaerobic digestion.

Abstract:
This is a textbook on treatment processes.

Interaction of Heavy Metals and Biological Sewage Treatment Processes.

Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, May 1965. 208p. (Available from National Technical Information Service (NTIS) as PB-168 840).

Key Words: chromium, BOD, COD, suspended solids, copper, cyanides, zinc, nickel, activated sludge, anaerobic digestion.

Abstract:

A combination of four metals, with a total concentration of 8.9 milligrams per liter, had no great effect on the overall efficiency of a pilot-scale activated-sludge plant. No synergistic action was noted. No difficulty with the anaerobic digestion of the sludges produced by the plant was encountered. Approximately 90 percent of the zinc, 54 percent of the copper, 37 percent of the chromium, and 31 percent of the nickel were removed from the influent sewage. The metals, in combination, behaved independently in their distribution throughout the process.

Nitrification in the experimental units was almost completely inhibited. This was shown to be a general symptom of heavy-metal toxicity. The ramifications of this inhibition are discussed.

With the exception of zinc, the metals passing through the activated-sludge process and discharged with the final effluent are predominantly in a soluble form. The effects of the metals discharged to the receiving stream were not considered in this study.

An Introduction to Experimental Aerobiology.

R.L. Dimmick and A.B. Akers, eds. Wiley, New York, 1969. 494p.

Key Words: viruses, coliforms, air.

Abstract:
There is nothing directly applicable to aerosols from activated sludges though there is a great amount of experimental work on aerosols in general available.

Irukayama, K.

The Pollution of Minamata Bay and Minamata Disease.

Advances in Water Pollution Research. 1966(3):153-180.

Key Words: mercury, surface water (marine), fish, shellfish.

Abstract:

CH_3HgCl was administered *per os* in 12 cases of cats with approximately 1 mg of Hg/kg/day, and various nervous symptoms similar to Minamata disease of cats, i.e., clumsiness in walking, unsteady movements, dullness, ataxic gait, tremor, blindness, paroxysmal fits, and other abnormal movements, appeared several weeks after the first administration. The difficulty of postural reflect was observed in the early stage and then ataxic gait of hind limbs appeared. All the cats did not exhibit identical symptoms; some of the cats revealed marked ataxia, and the others showed intensive paroxysmal fits. When a paroxysmal fit appeared, the stooped cat's forelimbs began to tremble, and it bent its ears backward and mewed. Then trembling of the head and a chewing movement with intensive salivation appeared. Dilated pupils showed no light reflex. Then the cat ran straight or in circles, and also exhibited a jumping motion. Sometimes a somersault-like movement and severe tonic and clonic cramp were seen. The duration of a fit was about one minute. Pathological disintegration and loss of the granule cells in the cerebellum and of the nerve cells in cerebral cortices were observed, with loss of Purkinje cells in the cerebellum in severe cases. These symptoms and findings were the same as those seen in spontaneously suffering cats. The lethal dose of CH_3HgCl in cats was 10-50 mg of Hg/kg and most often was 20 mg of Hg/kg.

Other methylmercury compounds such as $(CH_3Hg)_2S$, CH_3HgSCH_3, CH_3HgOH, etc., were administered *per os* in cats; similar symptoms and findings of those seen in spontaneously suffering cats were observed, and the lethal dose of these methylmercury compounds in cats was most frequently about 20 mg of Hg/kg. The lethal dose of the mercury compound in the shellfish from Minamata Bay in cats was calculated as 40-50 mg of Hg/kg.

CH_3HgCl and $(CH_3Hg)_2S$ were administered to rats daily in the amount of 1-2 mg of Hg/100 g. After the rats had taken 6-13 mg of Hg/100 g, body weight began to decrease, and their action became slow, with disabled

gait and extending hind limbs. Occasionally clonic cramps were seen. When the rats were held by the tail, strong flexion of limbs was observed. These symptoms were quite the same as in the spontaneously affected rats. The lethal dose of the mercury compound in the shellfish from Minamata Bay in rats was about 20 mg of Hg/100 g.

Isaacs, J.D.

Mutagenic Compounds and Mitotic Poisons.

Letter to Distribution of Institute of Marine Resources.
August 4, 1976.

Key Words: surface water (marine), fish.

Abstract:

This letter discusses the possibilities of developing tests for mutagenic compounds in seawater, determining the possibilities of a strong synergistic relationship between mutagens and mitotic poisons, and the possible entries into examining field specimens of microorganisms and fish for the effects of such material, etc.

Isensee, A.R. and G.E. Jones.

Distribution of 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) in Aquatic Model Ecosystem.

Environmental Science and Technology. 9:688-672. July 1975.

Key Words: herbicides, surface water (fresh).

Abstract:

Several organisms in a model ecosystem were exposed to 14 C-labeled TCDD for up to 31 days to determine the distribution of bioaccumulation potential in the aquatic environment. TCDD accumulation by all organisms was directly related to water concentration (0.05-1330 ppt) and averaged 2.0-21.6 x 10^4 (snail, Gambusia, and daphnid) and 4-9 x 10^3 (duckweed, algae, and catfish) times the water concentration. No metabolites of TCDD were found in submerged soil, water, snails, Gambusia, or catfish.

Ishizaki, C. and J.J. Cookson, Jr.

Influence of Surface Oxides on Adsorption and Catalysis with Activated Carbon.

In: Chemistry of Water Supply, Treatment, and Distribution. A.J. Rubin, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1975. pp. 201-231.

Key Words: pesticides, synthetic/organics, adsorption/ion exchange.

Abstract:

As a general conclusion it should be stated that an examination of the adsorption equilibrium alone does not provide enough information on the influence of carbon-surface chemistry on adsorption. In several cases, the equilibrium conditions are only slightly affected by surface oxides, but the rate of adsorption is reduced by more than 2 logs. A magnitude of this size can have appreciable influence on the contact time required for efficient treatment. Thus, the activation and regeneration procedure can have a significant influence on the efficiency of carbon for adsorption.

This study indicates that adsorption of these adsorbates on carbon is non-specific in that the surface coverage on an area basis varied little with surface chemistry. Acidic oxides hinder the equilibrium capacity to a small degree as a result of greater hydrogen bonding of water with the carbon's surface. Of a greater significance is the effect of acidic oxides and surface metals on the rate of adsorption.

Iskander, I.K. and D.R. Kesney.

Concentration of Heavy Metals in Sediment Cores from Selected Wisconsin Lakes.

Environmental Science and Technology. 8(2):165-170. February 1974.

Key Words: copper, zinc, cadmium, lead, chromium, nickel, surface water (fresh).

Abstract:

This article identified heavy metal levels in sediment from precultural times to present and provides a basis for composing natural backgrounds to what sewage and other sources are inputting into the system.

Jacobs, L.W. and D.R. Keeney.

Methylmercury Formation in Mercury Treated River Sediments During in situ Equilibration.

Journal of Environmental Quality. 3:121-125. April 1974.

Key Words: mercury, surface water (fresh).

Abstract:

An in situ experiment was established at two environmentally different river sites (one each on the Wisconsin and Fox rivers) to evaluate the extent of methylmercury (MeHg) production in and Hg loss from sediments treated with mercuric chloride ($HgCl_2$) or phenylmercuric acetate (PhHgAc). Bulk sediment was collected from each river site, treated with approximately 1, 10, or 100 ppm Hg (oven-dry basis) as $HgCl_2$ or PhHgAc, and returned to the river site with untreated controls for 2, 4, or 12 weeks of equilibration with the aquatic environment. After each sample retrieval, the sediments were analyzed for total Hg using an aqua regia digest and flameless atomic absorption spectrophotometry and for MeHg by gas chromatography using a modified extraction procedure which is described.

Results suggest that Hg losses from stationary sediments are minimal and that sediment transport is probably the major source of Hg movement in a river system. In both sediments, more MeHg was produced from PhHgAc than from similar concentration of $HgCl_2$, and MeHg concentration increased as the Hg treatment with either compound was increased. The HeHg concentrations found in the Wisconsin River sediments were substantially higher than in the Fox River sediments with a similar Hg treatment. The large differences in MeHg production between these two sediments may be partially attributed to their chemical dissimilarities. The Wisconsin River sediment is acidic and contains more organic materials compared to the Fox River sediment which is more alkaline and contains larger amounts of sulfide sulfur.

Jamieson, W.

Candida albicans as an Indicator of Pollution in Estuarine Water.

Ph. D. Thesis, New York University, 1974.

Key Words: coliforms, surface water (marine).

Abstract:

Investigations were carried out to ascertain the suitability of *Candida albicans*, a yeast-like fungus known to occur and survive in the marine environment, as an indicator organism of pollution in estuaries derived from human body wastes. Differential filtration and the membrane filter -- fluorescent antibody technique permitted the rapid concentration, identification, and quantification of the fungus from twenty weekly samples collected at three stations on the North Shore of Great South Bay, Long Island. Conventional indices of pollution such as total coliform and fecal coliform counts and total organic carbon determinations did not correlate well with the numbers of fungal cells present. Candida was shown to be a superior and more sensitive indicator of pollution originating from either fecal matter or from the skin and mucous membranes of man than the other methods tested.

Investigations of the die-off periods of several water-borne pathogens (*Candida albicans*, *Escherichia coli*, *Leptospira interrogans*, *Mycobacterium tuberculosis*, *Salmonella typhi*, *Shigella dysenteriae*, *Vibrio cholerae*, and *Yersinia enterocolitica*) showed that when exposed to sea waters of three salinities (5, 20, and 35%) at three temperatures (4, 25, and 37^{o}C) none of them survived longer than seven days, with the exceptions of *C. albicans* and *Mycobacterium tuberculosis*. Even this latter species, however, lost its viability by the eleventh day of exposure. *C. albicans*, on the other hand, after an initial drop in concentration, leveled off after day six at a more or less constant density, which was dependent only on termperature, and remained the same until the termination of the experiment on day thirteen.

It is concluded that with use of the membrane filter -- fluorescent antibody technique, the determination of *C. albicans* cell counts can serve

as a rapid, reliable, and practical method for defining the pollutional load of estuarine waters originating from human sources.

Jan, T. and D.R. Young.

Chromium Speciation in Municipal Wastewater and Seawater.

Southern California Coastal Water Research. Annual Report.
El Segundo, Calif., June 20, 1976. pp. 15-22.

Key Words: chromium, surface water (marine).

Abstract:

Chromium compounds occur principally in the particulate state in municipal wastewaters of southern California. Of the fraction that is dissolved, 97 to 99 percent is in the trivalent form; the measured concentrations of dissolved trivalent chromium agree quite well with those predicted from equilibrium calculations. In contrast, hexavalent chromium -- by far the most toxic form -- generally constitutes less than 1 percent of the total chromium found in these wastewaters. Chlorination does not significantly increase these hexavalent chromium concentrations.

The majority of dissolved chromium found in clean coastal seawater off southern California is hexavalent chromium. The sums of the concentrations of dissolved trivalent and hexavalent chromium measured in our samples are in good agreement with the values for total dissolved chromium measured by an independent process.

Subsurface seawater samples, known by their high levels of turbidity, ammonium-nitrogen, and particulate metals to have come from within the JWPCF wastewater plume, contained concentrations of particulate chromium up to 50 times control levels. In contrast, the concentrations of dissolved trivalent chromium in the plume samples were only 2 to 4 times background values, and those of dissolved hexavalent chromium showed no significant enhancements. There appears to be a relatively high natural background of dissolved hexavalent chromium in coastal seawater. The low percentage of municipal wastewater chromium that occurs in this toxic form (plus the apparent lack of conversion of other forms of chromium to it) indicate that significant increases in seawater concentrations of hexavalent chromium do not result from ocean discharge of these wastewaters.

Jebens, H.J. and W.C. Boyle.

Enhanced Phosphorus Removal in Trickling Filters.

Journal of the Sanitary Engineering Division, ASCE. 98(SA3):547-560. June 1972.

Key Words: phosphates, trickling filters.

Abstract:

Phosphorus removals obtained during a four month experimental design period for a synthetic media trickling filter pilot plant were not related to the operational parameters of hydraulic load, depth, recirculation, or waste strength; however, consistently greater removals of phosphorus than could be attributed to biological removal were measured. This bonus-removal of phosphorus was attributed to a chemical precipitation of phosphorus with cations present in the hard water wastewater. Slime samples from the pilot filters were found to contain crystalline aluminum phosphate as demonstrated by x-ray diffraction. Preserved slime samples released calcium and phosphorus in molar ratios compatible with an apatite precipitate. Release of phosphate from nonpreserved samples of filter slime suggested that precipitates of iron (III) phosphate were present.

The study reported herein supports the concept of enhanced-removal of phosphates in activated sludge as a means of obtaining phosphorus removals greater than that required for microbial growth. The synthetic filter media of this study supplied the high rates of oxygen transfer, and thus stripping of carbon dioxide, to raise the pH of the waste stream to the point where phosphates will precipitate naturally in hard water wastewaters. As in the activated sludge plants which exhibit bonus-removal of phosphates, this phosphate is trapped in the biological sludge produced.

Jellinek, H.H.G.

Soil Organics. I: Complexation of Heavy Metals; II: Bound Water.

Cold Regions Research and Engineering Laboratory, Hanover, N.H., September 1974. 57p. (Available from National Technical Information Service (NTIS) as AD-A008 868).

Key Words: iron, groundwater, surface water (fresh), crops, direct contact, aluminum, copper, nickel, lead, cobalt, zinc, manganese.

Abstract:

This paper is a very good summary of the complexation between humic and fulvic acids and heavy metals. Very strong, pH sensitive bond improves as compounds age. Humic and fulvic acids are shown to be polymer polyelectrolyte. Good theoretical development is included which could be combined with mass transfer kinetics analysis.

Jenkins, S.R., J. Engeset, and V.R. Hasfurther.

Model Sand Filters for the Removal of Colloidal Manganese Oxides Using Selected Cations as Filter Aids.

In: Chemistry of Water Supply, Treatment, and Distribution. A.J. Rubin, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1975. pp. 181-199.

Key Words: manganese, filtration.

Abstract:

The concentration of Ca^{2+} necessary to produce maximum removal effectiveness of δ-MnO$_2$ particles by model sand filters has been shown to be stoichiometric with the concentration of δ-MnO$_2$, thus indicating a specific chemical interaction between the Ca^{2+} and the manganese dioxide. These maximum effectiveness concentrations (mec) were similar to those concentrations of Ca^{2+} reported earlier as necessary to produce both aggregation of δ-MnO$_2$ and deposition of this oxide on a rotating disc surface. The mathematical-chemical relationship, derived to predict the most effective concentration of Ca^{2+} for coagulation of manganese oxide particles and deposition on silica surfaces, can be used to predict effective concentrations of Ca^{2+} for removal of δ-MnO$_2$ by model sand filters.

Differences in pH affect the mec of Ca^{2+} only slightly. However, precoating the sand with calcium ion causes considerable change in the effectiveness of Ca^{2+} in aiding δ-MnO$_2$ removal. It is most likely that the Ca^{2+} reacts with the negative -Si-O$^-$ surface sites reducing the number of sites available for a bonding with the -Mn-O-Ca$^+$ surface sites.

If Na$^+$ is used as a filter aid instead of Ca^{2+}, the mec required indicates that sodium ion compresses the diffuse part of the double layer. No stoichiometry exists between the mec of Na$^+$ and the δ-MnO$_2$ concentration. Thus, the destabilization of MnO$_2$ by Na$^+$ does not occur by a specific chemical interaction.

Jenne, E.A. and S.N. Luoma.

Forms of Trace Elements in Soils, Sediments, and Associated Waters: An Overview of Their Determination and Biological Availability.

In: Biological Implications of Metals in the Environment, Proceedings of the 15th Annual Hanford Life Sciences Symposium. U.S. Energy Research and Development Administration, Washington, D.C., 1977. pp. 110-143.

Key Words: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, copper, germanium, iron, lead, manganese, mercury, molybdenum, nickel, selenium, thorium, tin, uranium, zinc, surface water (fresh), surface water (marine).

Abstract:

Recent investigations reviewed herein indicate that the particular physiochemical forms of trace elements in waters and sediments are of major importance in determining the biological availability of trace elements to biota. The thermodynamic activity of the uncomplexed ion is probably the single most important factor affecting the biological availability of solute trace elements. Most of the data showing a decrease in trace element assimilation, by freshwater organisms, with increasing water hardness can be interpreted in terms of a decrease in activity of the element due to precipitation and to formation of carbonate, hydroxide, and other complexes. With some exceptions, complexation of solute trace elements by organic ligands also decreases their biological availability.

Experimental evidence indicates that trace element assimilation from solid forms (sediment) by detritus ingesting aquatic organisms is dependent upon trace element form, but occurs much slower than the assimilation rate from solute forms. The biological importance of solid forms of trace elements may be principally due to their regulation of equilibrium solute concentrations in the associated waters via sorption-desorption and dissolution-precipitation reactions.

Estimation of the quantity of trace elements present in the various solid forms, such as sulfides or carbonates, is rather qualitative. Most of the extractants used to estimate solid forms extract trace elements simultaneously from several sinks.

Thermodynamic data are missing for some trace element inorganic complexes and are only approximately known for other complexes. However, speciation with regard to common inorganic ligands is possible for several trace elements. Lack of information on complexes of naturally occurring organic ligands with trace elements is the major limitation in calculating overall trace element speciation in natural waters. The potential importance of these complexes is indicated by the similar molar concentrations of trace elements and dissolved organic substances and the high stability constants of the organic complexes of many such elements.

Jenne, E.A. and W. Sanders.

Literature on Mercury: Availability of English Translations.

JWPCF. 49(9):1952-1971. September 1971.

Key Words: mercury, surface water (marine).

Abstract:
This paper is simply a listing of available mercury papers on a worldwide basis up to 1971.

Jennett, J.C. and I.W. Santry, Jr.

Characteristics of Sludge Drying.

Journal of the Sanitary Engineering Division, ASCE.
96(SA5):849-863. October 1969.

Key Words: drying beds.

Abstract:
While this article does not deal with health effects, it provides background on sludge drying.

Jennett, J.C. and D.J. Harris.

Environmental Effects on Sludge Drying Bed Dewatering.

JWPCF. 45(3):449-461. March 1973.

Key Words: suspended solids, drying beds.

Abstract:

Within the range of environmental conditions studied in this investigation, the following conclusions can be made:

1. A relationship exists between sludge drainage and evaporation which is affected by the viscosity of the entrapped water. The importance of this effect is largely a function of sludge dry-bulb temperature.

2. Changes in sludge moisture content were not found to be related directly to relative humidity; however, a relationship was found to exist between the sludge drying rate and the operational variables ΔT (the difference between wet- and dry-bulb temperature) and ΔH (the difference between saturation and absolute humidity).

3. A relationship exists between the moisture gradient which developed within the sludge layer, ΔT, ΔH, and time. This relationship needs to be investigated more fully if sludge dewatering mechanisms are ever to be understood.

4. Laboratory investigations should study drainage and evaporation simultaneously if they are to describe sludge behavior on drying beds in field situations adequately. Additional operational variables that the authors feel would be desirable to include in future research include initial moisture content, radiant energy, and wind velocity. Specific resistance should be included as both an additional sludge characteristic and as a measure of viscosity, with the test being performed at the same dry-bulb temperature as the particular sludge dewatering experiment or run.

Jensen, E.T.

Sanitation of the Harvesting and Processing of Shellfish, 1965 Revision.

National Shellfish Sanitation Program Manual of Operations, Part 2. U.S. Public Health Service, Washington, D.C., Division of Environmental Engineering and Food Protection, Shellfish Sanitation Branch, 1965.

Key Words: shellfish, coliforms.

Abstract:
This paper has articles on harvesting and handling shell-stock, shucking and packing shellfish, packing and shipping shell-stock, repacking of shellfish, inspection, and coliform counts of stored oysters.

Jensen, L.D. and A.R. Gaufin.

Acute and Long-Term Effects of Organic Insecticides on Two Species of Stonefly Naiads.

JWPCF. 38(8):1273-1286. August 1966.

Key Words: pesticides, surface water (fresh), fish.

Abstract:

The results of this work indicate that synthetic organic insecticides have a cumulative effect, and that a relatively large application factor would be necessary when using static four-day bioassay results for estimating safe concentrations of these insecticides over extended periods. Moreover, concentrations of insecticides which kill some of the test organsisms inevitably produce subtle sublethal effects on survivors. These effects constantly are overlooked and yet they may alter the ecological interrelationships of entire populations of aquatic animals. Changes in the normal behavior of affected animals frequently lead to the exposure of these animals to predation. Changes in the length of time between developmental stages of aquatic insects may prevent emergence during favorable climatic conditions and ultimately lead to the extinction of a species from affected streams. The aquatic biologist must evaluate these influences and interrelationships in terms of population-wide exposures to sublethal concentrations of pesticides.

Jeris, J.S. and R.W. Owens.

Pilot-Scale High-Rate Biological Denitrification.

JWPCF. 47(8):2043-2057. August 1975.

Key Words: nitrates, nitrification/denitrification.

Abstract:

High-rate denitrification in a fluidized bed of sand covered with denitrifying biomass has been demonstrated successfully at a moderate-sized pilot installation treating 36,000 gpd (136,000 l/day).

The system consistently produced greater than 99 percent removal of the influent nitrogen in less than 6.5 min at a flux rate of 15 gpm/sq ft (620 l/min/sq m).

The full potential of this system still remains to be investigated. Although the average removal was 335 lb of NO_3-N/day/1,000 cu ft (5,450 kg/day/cu m) of reactor volume, the system demonstrated that it could remove up to 1,275 lb N/day/1,000 cu ft (20,700 kg/day/cu m).

Nitrogen removal efficiency was not affected by diurnal flow variation and a 17-hr shutdown.

The operational routine was simple and trouble-free and required very little time.

Concentrations of nitrate nitrogen much greater than would be expected in typical municipal plants can be removed.

Jeris, J.S., C. Beer, and J.A. Mueller.

High Rate Biological Denitrification Using a Granular Fluidized Bed.

JWPCF. 46(9):2118-2128. September 1974.

Key Words: nitrates, nitrites, ammonia, nitrification/denitrification.

Abstract:

The authors believe that the fluidized biological bed concept has excellent potential for treatment of nitrified secondary effluents and for water and wastewater containing objectionable concentrations of nitrate or nitrite nitrogen. The fluidized biological bed has demonstrated the capacity to handle extremely high hydraulic and nitrogen loadings with correspondingly low detention times.

Additional research is desirable to refine and improve the techniques employed. The technique for control of solids growth *in situ* or external to the reactor can be refined Based on the high removal rates obtained in the laboratory scale studies, upscaling the work to a larger reactor and using nitrified wastewater effluent seems to be in order now.

Jernelov, A. and S. Jensen.

Biological Methylation of Mercury in Aquatic Organisms.

Nature. 223:753-754. August 1969.

Key Words: mercury, fish.

Abstract:

This article shows that both mono and dimethyl forms of mercury can be produced in bottom sediments and in fish.

Jernelov, A., L. Landner, and T. Larsson.

Swedish Perspectives on Mercury Pollution.

JWPCF. 47(4):810-822. April 1975.

Key Words: mercury, surface water (fresh).

Abstract:

This article gives data on time change functions in methylation of mercury, as well as a brief historical review of the research on mercury in the aquatic environment and an outline of the present state-of-the-art from a Swedish point of view.

Jewell, W.J. and R.J. Cummings.

Denitrification of Concentrated Nitrate Wastewaters.

JWPCF. 45(9):2281-2291. September 1975.

Key Words: COD, nitrates, suspended solids, nitrites, nitrification/denitrification, effluent characteristics.

Abstract:
The following conclusions were made:

1. Two biological denitrification processes, SFC and CMSGR, efficiently removed concentrations of nitrate nitrogen and COD as high as 4,000 and 14,600 mg/l, respectively.

2. At comparable loadings and 80 percent removal efficiency, the SFC units could remove 30 times as much nitrate nitrogen as the CMSGR units at half the hydraulic detention period.

3. The sludge developed in both processes was very dense (30 percent volatile) and adhesive. Its physical nature produced maximum effective sludge (VSS) concentrations of 300,000 and 15,000 mg/l for the SFC and CMSGR, respectively.

4. At high feed concentrations of NO_3-N, large volumes of nitrogen gas tended to lift SS and caused high concentrations in the effluent from the CMSGR but not from the SFC units, although the latter lacked a clarifier. The average concentration of SS in the effluent from the SFC was one-fifth to one-sixth that from the CMSGR.

5. No significant nitrite concentrations were observed in the effluent.

6. At high concentrations and loading rates, a significant increase in removal rates was observed with the SFC units.

7. The maximum unit mass removal rates were 0.38 and 0.45/day for the CMSGR and the SFC units, respectively.

The average ratio of COD removed: NO_3-N removed was 2.80 for the CMSGR units and 3.20 for the SFC units. However, there always seemed to be an excess of COD because the amount removed was always significantly less than the amount supplied.

Jinks, S.M. and M. Eisenbud.

Concentration Factors In the Aquatic Environment.

Radiation Data and Reports. 5:243-247. May 1972.

Key Words: germanium, cobalt, zinc, iron, iodides, manganese, fish, shellfish, strontium, cesium.

Abstract:

Concentration factors for various freshwater and marine organisms as gathered from the literature are presented. Attention is called to the existence of considerable variability in the reported values, and the reasons for this variability are briefly discussed. In addition to the difference in concentration factors for the marine and freshwater environments and because of differences in concentrations of stable elements in the two systems, other sources of variability include errors in sampling and analysis, physiological factors, and ecological disequilibria.

Johnson, C.M.

Molybdenum.

In: Diagnostic Criteria for Plants and Soils. H.D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 286-301.

Key Words: molybdenum, ponding/land application, agriculture, groundwater.

Abstract:

The author describes plant criteria useful in diagnosing molybdenum deficiency, indicator plants for molybdenum deficiency, indications of molybdenum excess in plants and animals, tissue analysis values, soil criteria useful in diagnosing molybdenum status, forms of molybdenum suitable for control and methods of correcting molybdenum deficiency.

Johnson, D.E., R.J. Provost and S.S. Kalter.

A Proposal for Evaluation of the Health Effects Associated with the Application of Wastewater to Land.

U.S. Army Medical Research and Development Command, Washington, D.C., 1975.

Key Words: viruses, bacteria, ponding/land application, air.

Abstract:

A literature survey accompanies this proposal to examine aerosols from spray irrigation of secondarily-treated effluent for pathogenic bacterial and viral microorganisms.

Johnson, E.L., J.H. Beeghly, and R.F. Wukasch.

Phosphorus Removal With Iron and Polyelectrolytes.

Public Works. 100:66-68, 142. November 1969.

Key Words: phosphates, chemical treatment.

Abstract:

Total phosphorus removal of 90.9 percent with a residual of 0.70 mg/l in the final effluent was attained by feeding approximately 20 mg/l Fe as $FeCl_3$ and 0.3 mg/l Purifloc A-23 to the raw wastewater. Soluble, ortho, and total phosphorus removals during the entire trial averaged between 87.2 and 90.9 percent, respectively. The concentration of ortho and soluble phosphorus was less than 0.6 mg/l in the final effluent.

Suspended solids removal in the primary clarification tank was greatly improved. As much as 92 percent removal was attained. Final suspended solids removal was increased from 85.8 to 92.5 percent.

Sludge volumes from the plant were decreased due to increased sludge solids concentration. The aeration system benefited by higher dissolved oxygen levels and the activated sludge settling improved. Sludge volume index was reduced from 85 to 64. There were no indications of "phosphorus starvation" in the aeration system.

Digester operation was not altered due to chemical feeding. Gas production increased. Soluble phosphates were not released.

The plant scale trial results were closely predicted by the laboratory and plant feasibility study.

Johnson, J.D.

Disinfection: Water and Wastewater.

Ann Arbor Science Publishers, Ann Arbor, Mich., 1975. 418p.

Key Words: bacteria, synthetic organics, chlorination,
adsorption/ion exchange.

Abstract:

This book describes the chemical and microbiological treatment of drinking, swimming and wastewater with bromine, iodine and ozone as well as chlorine. It explains the "why" of water and wastewater disinfection; it shows how competition between the chemical, physical and microbiological processes results in overall disinfection efficiency, observed for the classical old and soon-to-be-tried new disinfectants.

Edited by a leading disinfection authority, each of the 18 chapters is written by an expert in his field. Topics include physical and analytical chemistry of the halogens and ozone and the kinetics of their application to water and wastewater disinfection processes, techniques of application of water disinfectants to waste and wastewater, the importance of mixing and disinfection processes, proposed new water and wastewater disinfectants and their economics as well as advanced water and wastewater disinfection processes. Further chapters delve into disinfection kinetics and the processes affecting the rate of microbial disinfection, such as lumping and chemical speciation, especially on viruses, cysts and spores. Finally, it presents the chemistry of water and wastewater disinfection and its effect on the efficiency of practical disinfection systems.

Johnson, J.D. and R. Overby.

Bromine and Bromamine Disinfection Chemistry.

Journal of the Sanitary Engineering Division, ASCE.
97(SA5):617-628. October 1971.

Key Words: viruses, bacteria, bromine disinfection.

Abstract:

The following conclusions were reached:

1. Bromination offers promise as a method for disinfection and chemical purification for small water supplies and swimming pools where water quality is low.

2. Bromine unlike chlorine is an effective disinfectant in the HOBr form at high pH values near 9.

3. Bromine unlike iodine is an effective disinfectant in the Br_2 form at high bromide concentration and low pH.

4. Bromine and the bromamines unlike the chloramines are good disinfectants especially against virus and spores. Previous poor results were probably due to a loss of bromine through breakpoint reduction reactions.

5. Rapid breakpoint reduction of bromine occurs at a 2:3 ammonia to bromine mole ratio, but in excess bromine reduction nearly stops with the formation of tribromamine. Chlorine breakpoint reduction by ammonia, however, requires more chlorine and continues beyond breakpoint.

6. Bromine reacts rapidly with ammonia while chlorine reacts slowly at the extremes of pH.

7. Bromine disinfection results like chlorine must be interpreted on the basis of chemical and residual concentrations while dosage interpretations are, in general, meaningless.

Johnson, J.E.

The Public Health Implications of Widespread Use of the Phenoxy Herbicides and Picloram.

BioScience. 21(17):899-905. September 1971.

Key Words: herbicides, epidemiology.

Abstract:

This article discusses the toxicity of: 2,4-D and 2,4,5,-T, silvex, picloram, and dioxine.

Johnson, J.N.

Mercury in Bottom Sediments of Palos Verdes.

Southern California Coastal Water Research Project. Annual Report. El Segundo, Calif., June 30, 1974. pp. 129-132.

Key Words: mercury, surface water (marine).

Abstract:

This article presents a comparison of mercury levels in sediment from 1972 and 1973. Some sampling stations increased; some decreased.

Johnstone, D.L.

Survival of Escherichia coli in Oligotropic Waters.

Washington State University, Pullman, Dept. of Civil and Environmental Engineering, June 1974. 75p. (Available from National Technical Information Service (NTIS) as PB-234 461).

Key Words: Escherichia coli, coliforms, protozoa, surface water (fresh).

Abstract:

The effects of the indigenous microflora and microfauna of oligotrophic high-mountain waters upon the survival of fecal coliforms have been studied. Surface water and periphytic (aufwuchs) populations were examined for their anti-coliform activity at 0C, 5.5C, and 11C. The most pronounced coliform die-off occured at 11C. At this temperature, the indigenous bacterial and protozoan populations increased in density most readily. Periphytic populations were more effective in coliform eradication than surface water populations at all tested temperatures. In both surface water and periphytic samples, a peritrichously flagellated protozoan, tentatively identified as Colpidium sp., was observed actively feeding on the coliform populations following repeated exposure of coliforms to the indigenous microorganisms. Several genera of psychrophilic bacteria were isolated from these waters. Of these, 13 isolates of Cytophaga sp. have been shown to be facultative psychrophiles.

Jolley, R.L.

Chlorine-Containing Organic Constituents in Chlorinated Effluents.

JWPCF. 47(3):601-618. March 1975.

Key Words: aluminum, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, manganese, mercury, nickel, lead, zinc, synthetic/organics, effluent characteristics, chlorination.

Abstract:

In the initial radioactive tracer experiment (RT-1) that was used to evaluate the coupled ^{36}Cl tracer, high resolution chromatographic technique for its usefulness in examining chlorination effects on effluents, it was determined that chlorine-containing constituents are formed when primary effluent is chlorinated.

Jones, W.W.

Nitrogen.

In: Diagnostic Criteria for Plants and Soils. Homer D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 310-232.

Key Words: nitrates, ponding/land application, land reclamation, groundwater.

Abstract:

Nitrogen as a plant nutrient is treated in a great number of publications indicating not only the importance of nitrogen in the physiology of plants, but also the difficulty of establishing critical levels for its use. The author discusses visual symptoms of and indicator plants for nitrogen deficiency or excess, tissue analysis values, kinds of soil in which nitrogen deficiency or excess most commonly occurs, soil management and other practices which influence soil nitrogen, soil analysis values of significance and control of nitrogen deficiency and excess.

Johnstone, D.L. and A.M. Kubinski.

Survival of Intestinal Bacteria in Oligotrophic Waters.

Washington State Research Center, Pullman, July 1973.
37p. (Available from National Technical Information
Service (NTIS) as PB-232 156).

Key Words: fecal streptococci, coliforms, bacteria, surface water (marine).

Abstract:

Direct predator-prey relationships involving a few species of ciliated and flagellated protozoans from the periphyton of oligotrophic waters appear to be the major mechanism in such environments responsible for removal of fecal bacteria. Other factors, such as the indigenous bacterial flora and the physicochemical properties of these waters, are relegated to a more indirect role. The lengthy lag period (4-5 days) required for initial predatory responses indicated the delicate nature of high-quality waters and the need for strict sanitary guidelines to ensure their future safety and quality. The sanitary quality of oligotrophic waters can best be determined by the enumeration of fecal streptococci in conjunction with fecal coliforms.

Jordan, T.A., M.M. Ghosh, and R.H. Boyd, Jr.

Physico-Chemical Aspects of Deep-Bed Filtration.

JWPCF. 46(12):2745-2754. December 1974.

Key Words: suspended solids, filtration.

Abstract:

A conceptual model has been developed to predict the capture efficiency of suspended particles in granular filters for systems exhibiting negligible double-layer forces. This model is an extension of that proposed by Spielman and Fitzpatrick for the filtration of non-Brownian particles. It considers simultaneously the effects of Brownian diffusion, hydrodynamic forces, London forces of attraction, and direct interception as major mechanisms. For most common water and wastewater filtration systems, gravity seems to play a minor role.

The collection of particles with sizes larger than 1.0 m and with $N_{AD} < 1$ is almost quantitatively described by the model proposed by Spielman and Fitzpatrick, even for systems where $\Gamma \ll 1$. This indicates that in the removal of large particles double-layer repulsion plays only a minor role compared with other mechanisms.

The capture of Brownian-sized particles for systems in which $\Gamma \ll 0.1$ is well described by the model developed in this study, which includes the effect of Brownian diffusion in the model proposed by Spielman and Fitzpatrick. The present model describes removal of suspended particles from secondary effluents satisfactorily.

The removal of colloidal particles from wastewaters may be greatly improved by proper design and control of the filtration process. Preconditioning of filter influents by using electrolytes may enhance the performance of granular filters.

Jurinak, J.J., and J. Santillan-Medrano.

The Chemistry and Transport of Lead and Cadmium in Soils.

Utah Agricultural Experiment Station, Logan, June 1974.
121p. (Available from National Technical Information Service (NTIS) as PB-237 497).

Key Words: lead, cadmium, ponding/land application, land reclamation.

Abstract:

The following conclusions were reached:

1. A predictive model of heavy metal ion transport in soil systems can be developed based on the thermodynamic and exchange data.

2. Extractable phosphate and pH in soil systems are of importance in the reduction of heavy metal concentration in soil solutions.

3. The main mechanism of lead retention in noncalcareous soil systems is precipitation as lead hydroxides and/or lead pyromorphites. Lead carbonate can possibly also form in calcareous soils at about pH 8.

4. Cadmium concentrations in soil solutions cannot be reduced to low levels by precipitation. Exchange or adsorption is the important mechanism involved in the retention of cadmium especially at low Cd concentrations.

5. Lead reacted with soil systems at a greater rate than did cadmium.

6. Cadmium is more mobile in soil systems than lead because of its higher solubility and slower rate of reaction.

7. Cadmium reactions and stable phases in natural systems have not been studied as thoroughly as their lead counterparts. There is a paucity of thermodynamic data.

8. In heavy metal reaction with soil, the most stable precipitate is not formed instantaneously or necessarily in a direct reaction path. Precipitation occurs in steps from metastable to more stable compounds.

9. Basic soils of arid and semi-arid regions constitute essentially an infinite sink for lead. The movement of lead in percolating water in these soils is essentially nil even in the presence of large amounts of excess salt. In this respect, arid zone soils are an excellent medium for scavenging for lead and other chemically similar heavy metals from industrial waste with minimal danger of groundwater pollution. Cadmium relative to lead is less efficiently removed from percolating waters by these soils.

Jurinak, J.J., S.H. Lai, and J.J. Hassett.

Cation Transport in Soils and Factors Affecting Soil Carbonate Solubility.

EPA-R2-73-235, Utah State University, Logan, May 1973. 90p. (Available from National Technical Information Service (NTIS) as PB-222 006).

Key Words: elemental contaminants, groundwater, surface water (fresh).

Abstract:

A predictive model of cation transport in soils was developed and tested. This model involved the definition of the cation exchange process in soil columns during the miscible displacement of cation solutions. A mass balance equation was formulated which included a general nonlinear exchange function. The solution of the equation was accomplished by numerical methods. The method was applied to the transport of cations through an exchanger using five different types of exchange functions. The model was further tested by conducting soil column studies where both homovalent and heterovalent exchange occurred. The agreement between predicted cation transport in soils and experimental data was good.

Laboratory studies were also conducted, using the carbonate saturometer, to assess the effect of Mg^{+2} ion on the solubility of calcareous materials. Carbonate solubility in the presence of Mg^{+2} ion was found to vary with the surface area of the solid phase, the mineralogy of the carbonate material, and the degree of saturation of the water with respect to a given carbonate mineral. Calcite generally increased in solubility, when Mg^{+2} was present, in waters which were unsaturated with respect to calcite. Carbonate material which contained magnesium as a constituent ion, e.g., dolomite, decreased solubility as Mg^{+2} concentration increased in waters which were near saturation with respect to dolomite.

Kadlec, J.A., R.H. Kadlec, and C.J. Richardson.

The Effects of Sewage Effluent on Wetland Ecosystems.

Semi-Annual Report No. 1 to Research Applied to National Needs.
University of Michigan, Ann Arbor, 1974.

Key Words: nitrates, nitrites, phosphates, coliforms, surface water (fresh), nitrification/denitrification.

Abstract:

One of the principal effects of discharging effluent from the secondary sewage treatment plants into natural waters is to increase the concentration of certain ions in those waters. These ions are nutrients which stimulate plant growth, especially algae, which may be objectionable in lakes and streams. Plant growth, particularly of non-algal species, is not objectionable in wetland-marshes and bogs-and discharge into such areas may be an alternative to lake or stream discharge. Thus, one important phase of this study is the monitoring of a select set of these ions under natural and perturbed conditions.

Kadlec, R.H.

Feasibility of Utilization of Wetland Ecosystems for Nutrient Removal from Secondary Municipal Wastewater Treatment Plant Effluents.

University of Michigan, Ann Arbor, 1976.

Key Words: surface water (fresh).

Abstract:

A major environmental problem is the cleansing and safe disposal of human wastes. Staff members at the University of Michigan believe they have found a natural system which minimizes the damage caused by human waste at a considerable saving to the communities involved.

Primary treatment provided by the stabilization lagoons at every sewage plant removes solid material from wastewater; further treatment is necessary to remove the high level of nutrients that remain in the flow.

It was proposed that a marsh might act as a natural cleanser by trapping the nutrients in the water before they reach lakes and streams. By using the natural marsh, construction costs and dependence on advanced technology would be reduced, and there might even be benefits to the marsh in the form of improved wildlife habitat and increased growth.

A limited irrigation test program was conducted using artificial wastewater in a small representative area of the marsh; plant and insect studies were conducted and, on the basis of the small-scale program, it was determined that irrigation would have no short-term adverse effect on the marsh and the marsh was quite efficient at nutrient removal.

A full-scale test system was completed and approximately 2.5 million gal of treated wastewater were pumped into the swamp over a period of 3 mos. So far, the data obtained indicates that the impact of the irrigation project is minimal and that nutrients were removed from the water from the treatment plant.

Kadlec, R.H., C.J. Richardson, and J.A. Kadlec.

The Effects of Sewage Effluent on Wetland Ecosystems.

University of Michigan, Ann Arbor, 1974.

Key Words: ammonia, nitrates, iron, chlorides, coliforms, bacteria, parasitic worms, crops.

Abstract:

A two year decomposition study was set up using four plant groups (Cardex, Salix, Chamaedaphne and Betula) representing the majority of the vegetation on the Porter Ranch peatland beginning August 1973. Decomposition bags made of nylon meshing were used to retain the vegetation. In addition the bags were placed in treatment plots and received fertilizer simulating sewage effluents. Preliminary results show weight losses and nitrogen levels appear to increase during the first year. Further data analyses is necessary before any final conclusions can be made.

Kadlec, R.H., C.J. Richardson, and J.A. Kadlec.

The Effects of Sewage Effluent on Wetland Ecosystems.

Semi-Annual Report No. 4 to Research Applied to National Needs. University of Michigan, Ann Arbor, 1975.

Key Words: ammonia, chlorides, nitrates, iron, biological contaminants, coliforms, bacteria, crops.

Abstract:

The impact of the use of wetland ecosystems for the tertiary treatment of sewage effluents has not been investigated in detail. More specifically, the effects of effluents on the growth and productivity of vascular plants in wetlands has not been studied. This study was conducted on a north-central Michigan peatland to determine the effects of sewage effluents on the growth and productivity of several common peatland plants. Emphasis throughout the experiments was on practical application and the consequences of using the peatland as a disposal site.

Although some changes in plant species composition and productivity are possible, it is unlikely that rapid or extensive degradation of the peatland will occur. It is possible that denitrification and phosphate adsorption onto the peat will have significant effects on the availability of plant nutrients. Assuming that sewage effluent will add nutrients at a rate approximately the same as that tested, it appears that the effluents will have no direct detrimental effects on most of the plants now present on the site.

Kahanovitch, Y. and N. Lahav.

Occurrence of Pesticides in Selected Water Sources in Israel.

Environmental Science and Technology. 8(8):762-765. August 1974.

Key Words: pesticides, dieldrin, endrin, surface water (fresh).

Abstract:

Gas chromatography was used to determine the concentrations of 12 organic pesticides in selected water samples taken from various parts of Israel during the period 1972-73. The only samples which did not contain pesticides were those from the Dan River and the drainage water from the Dan River and the drainage water from agricultural fields. In most of the samples, pesticide concentrations on the order of several nanograms per liter were found. The most widespread compounds were lindane and a-BHC, with o.p'-DDD (TDE), p.p'-DDT, dieldrin, and endrin being found in small quantities in some samples. The relatively high concentrations of lindane in municipal sewage samples indicate that this is an important source of BHC in the water bodies under investigation. The relatively low and constant pesticide levels in Lake Kinneret and the other water reservoirs probably reflects the buffering action of the bottom sediment of these bodies.

Kalinske, A.A.

Enhancement of Biological Oxidation of Organic Wastes Using Activated Carbon in Microbial Suspensions.

Water and Sewage Works. 119(6):62-64. June 1972.

Key Words: COD, suspended solids, activated sludge, adsorption/ion exchange.

Abstract:

These studies indicate that the extremely versatile and economical activated sludge process for degradation of soluble organic wastes can be very significantly improved, with a minor additional expenditure, by maintaining in the aerated microbial suspension granular activated carbon which provided extensive "concentration sites" for the soluble organics, bacteria, and oxygen.

Kampelmacher, E.H. and L.M. Van Noorle Jansen.

Occurrence of Salmonella in Oxidation Ditches.

JWPCF. 45(2):348-352. February 1973.

Key Words: salmonella, ponding/land application.

Abstract:

Pilot studies have shown that, in contrast to conventional wastewater treatment plants, exact measurement of salmonella reduction in oxidation ditches was not feasible. However, it was possible to determine the MPN of salmonella bacteria in the influent, circuit liquid, and effluent during certain periods. In this way the biosystem of the installation with regard to salmonella could be evaluated. Results indicated that the capacity of the oxidation ditch to remove salmonella was not inferior to that of conventional treatment plants. Salmonella contamination occurring naturally in one of the treatment plants could be traced to its source. These investigations support the theory about the circulation of salmonella bacteria through the natural system.

Kampelmacher, E.H. and L.M. van Noorle Jansen.

Reduction of Bacteria in Sludge Treatment.

JWPCF. 44(2):309-313. February 1972

Key Words: salmonella, bacteria, chemical treatment, vacuum filters.

Abstract:

The filtration of sludge, carried out with the aid of ferric chloride or ferrous sulfate and lime and with the aid of vacuum filters, yields an end product in which the number of bacteria is considerably reduced. In the sludge treatment plants at Apeldoorn and Mierlo, a reduction of the order of two decimals was found for the aerobic bacteria and of the order of two to three decimals for the content of enterobacteriaceae. In the plant in Maastricht, the reduction in the number of aerobic bacteria was of the order of three decimals and that of enterobacteriaceae of four decimals. In all three plants, salmonella contamination of the dry sludge was significantly less than that of the wet sludge.

Kampelmacher, E.H. and L.M. Van Noorle Jansen.

Reduction of Salmonella in Compost on a Hog-Fattening Farm.

JWPCF. 43(7):1541-1545. July 1971

Key Words: salmonella, surface water (fresh).

Abstract:

The reduction of salmonella in compost in an experimental oxidation vat on a hog-fattening farm was shown to be approximately 100-fold. As long as the excretion of salmonella in the feces of the hogs remains low, only small numbers of salmonella bacteria will be sluiced out with the effluent; thus, the possibility of human and/or animal infection in surface water may be regarded as very slight. As soon as either the number of hogs or the number of excreted bacteria, or both, increases, the plant can no longer adequately reduce the number of salmonellae to the extent that the effluent can be sluiced out into open water without the danger of human or animal infection. Therefore, it is recommended that adequate chlorination of the effluent of such plants be considered.

Kampelmacher, E.H. and L.M. van Noorle Jansen.

Salmonella - Its Presence in and Removal from a Wastewater System.

JWPCF, **42**(12):2069-2073. December 1970.

Key Words: salmonella, influent characteristics, effluent characteristics.

Abstract:

When 3 x 10" *S. utrecht* germs were added to influent, an average of 60 germs/100 ml effluent were recovered in 10.5 hr. If this is compared with the amounts of salmonella germs normally found in the effluent (100 germs/100 ml), it can be maintained that some 10^{10} salmonella germs continuously enter the plant per hour, while some 10^9 salmonella germs are released from the plant every hour with the effluent (in 1,500 cu m) into publicly accessible water. In view of this situation, the feasibility of disinfection of effluent merits consideration.

Kamps, L.R., R. Carr, and H. Miller.

Total Mercury-Monomethylmercury Content of Several Species of Fish.

Bulletin of Environmental Contamination and Toxicology. 8(5): 273-279. November 1972.

Key Words: mercury, fish.

Abstract:

Comparative data from samples show that mercury in the edible portion of swordfish, tuna fish, northern pike, white bass, and perch is essentially all monomethyl mercury.

Kaneko, T. and R.R. Colwell.

Adsorption of Vibrio parahaemolyticus on to Chitin and Copepods.

Applied Microbiology. 29(2):269-274. February 1975.

Key Words: bacteria, surface water (marine).

Abstract:

Vibrio parahaemolyticus was observed to adsorb onto chitin particles and copepods. The efficiency of adsorption was found to be dependent on pH and on the concentration of NaCl and other ions found in seawater. Highest efficiency was observed in water samples collected from Chesapeake Bay and lowest in water from the open sea. V. parahaemolyticus was found to adsorb onto chitin with the highest efficiency of the several bacterial strains tested. Escherichia coli and Pseudomonas fluorescens did not adsorb onto chitin. The adsorption effect is considered to be one of the major factors determining the distribution of this species and affecting the annual cycle of V. parahaemolyticus in the estuarine system.

Kaneko, T. and R.R. Colwell.

Distribution of Vibrio parahaemolyticus and Related Organisms in the Atlantic Ocean off South Carolina and Georgia.

Applied Microbiology. 28(6):1009-1017. December 1974

Key Words: bacteria, surface water (marine).

Abstract:

The distribution of Vibrio parahaemolyticus and related organisms in the Atlantic Ocean was determined during the summer of 1971 from samples collected at stations along four transects on the continental shelf off the South Carolina and Georgia coasts. No V. parahaemolyticus strains were isolated from any of the samples of seawater (surface and bottom), sediment, and plankton which were collected. A numerical taxonomy analysis of data on substrate utilization, including 154 organic compounds serving as single carbon sources, was carried out, and four groups of strains were observed. Each group showed well-separated distribution profiles from shore out to the continental shelf. That is, the groupings were observed to correspond to coastal, off-shore and intermediate distribution patterns for the strains. This study provides a useful example of the kind of ecological distributional analysis of bacteria which can be accomplished with numerical taxonomy.

Kaneko, T. and R.R. Colwell.

Ecology of Vibrio parahaemolyticus in Chesapeake Bay.

Journal of Bacteriology. 113(1):24-32. January 1973.

Key Words: bacteria, surface water (marine).

Abstract:

A study of the ecology of Vibrio parahaemolyticus and related vibrios in the Rhode River area of Chesapeake Bay was carried out over the period December 1970 through August 1971. The incidence of V. parahaemolyticus and related vibrios was found to be correlated with water temperature. The vibrios could not be detected in the water column during the winter months, although they were present in sediment. From late spring to early summer, when water temperatures were 14 ± 1 C. vibrios over-wintering in sediment were released from the bottom communities and attached to zooplankton, proliferating as the temperature rose. The number of vibrios in and on plankton was reflected in the water column bacterial population densities at water temperatures of ca. 19 C. Thus, temperature of the water column in the range of 14 to 19 C was found to be critical in the annual cycle of the vibrios. Interaction between sediment, water, and zooplankton was found to be essential in the natural estuarine ecosystem. Bacterial counts of zooplankton were found to be temperature dependent. The bacterial population associated with zooplankton was found to be predominantly on external surfaces and was specific, differing from that of the sediment. Vibrio spp. and related organisms comprised the total bacterial population associated with zooplankton in summer months. The ecological role of Vibrio spp., including V. parahaemolyticus, was found to be significant with respect to their property of chitin digestion and in relation to the population dynamics of zooplankton in Chesapeake Bay.

Kaneko, T. and R.R. Colwell.

Incidence of *Vibrio parahaemolyticus* in Chesapeake Bay.

Applied Microbiology. 30(2):251-257. August 1975.

Key Words: bacteria, surface water (marine).

Abstract:

A Bay-wide survey of the distribution of Vibrio parahaemolyticus was carried out in Chesapeake Bay during May 1972, to determine whether the annual cycle of V. parahaemolyticus which was observed to occur in the Rhode River subestuary of Chesapeake Bay took place in other parts of Chesapeake Bay. In an earlier study, April to early June, when the water temperature rises from 14 to 19 C, was found to be a critical period in the annual cycle of the organism in the Rhode River, since this is the time period when the annual cycle is initiated. Results of this study, however, revealed that V. parahaemolyticus could not be found in the water column during May 1972. Nevertheless, several samples of sediment and plankton yielded V. parahaemolyticus isolates. Comparison of data with those for the Rhode River area examined in the earlier studies of the annual cycle of V. parahaemolyticus suggests that the time of initiation of the annual cycle of V. parahaemolyticus in the open Bay proper may be influenced by various factors such as temperature and salinity, i.e., deeper water locations may show initiation of the V. parahaemolyticus annual cycle later than shallow areas. Confirmation of the presence of the organism in the samples studied was accomplished using numerical taxonomy with 19 reference strains also included in the analyses.

Kaneko, T., R.R. Colwell, and F. Hamons.

Bacteriological Studies of Wicomico River Soft-Shell Clam (Mya arenaria) Mortalities.

Chesapeake Science. 16(1):3-13. March 1975.

Key Words: viruses, bacteria, surface water (marine).

Abstract:

Bacteriological studies were carried out to determine a causative agent of soft-shell clam mortalities occurring in Chesapeake Bay, i.e., Eastern Bay to the Wicomico River, in midwinter, 1970 and through 1971. Several screening tests were performed in preliminary experiments designed to detect the presence of potential pathogens. Growth of 57 cultures isolated from count plates was tested at cold temperatures over long periods of time. Sixteen strains grew under the conditions employed in this screening and of these, eight strains were found to cause death of all animals within 48 hours and to show good growth at 4 C within one week. Numerical taxonomy was employed to identify and classify the isolates. Two of the eight strains, one identified as a member of the Enterobacteriaceae and the other as a Vibrio sp., were considered to be potential pathogens for the soft-shell clam. Direct evidence of the pathogenicity of these strains is not yet conclusive, although pathogenicity is strongly indicated from the results of experiments carried out in this study.

Kanisawa, M. and H.A. Schroeder.

Life Term Studies on the Effects of Arsenic, Germanium, Tin, and Vanadium on Spontaneous Tumors in Mice.

Cancer Research. 27:1192-1195. July 1967.

Key Words: arsenic, germanium, tin, epidemiology.

Abstract:

Mice fed a diet low in many trace elements and raised in an environment where contamination from extraneous trace elements was controlled were given small amounts (5 μg/ml) of arsenite, germanate, stannous, or vanadyl ions in drinking water for their life times. Animals receiving arsenite had a significantly decreased incidence of all tumors, and of tumors of the lung, compared to those receiving tin, vanadium, and to controls. Fewer spontaneous tumors were also found in animals given germanium. Significant differences in the incidences of malignant tumors did not appear. None of the elements was carcinogenic in the doses given.

Kapikian, A.Z., R.G. Wyatt, R. Dolin, T.S. Thornhill, A.R. Kalica, and R.M. Chanock.

Visualization by Immune Electron Microscopy of a 27-nm Particle Associated with Acute Infectious Nonbacterial Gastroenteritis.

Journal of Virology. 10(5):1075-1081. November 1972.

Key Word: epidemiology.

Abstract:

A 27-nm particle was observed by immune electron microscopy in an infectious stool filtrate derived from an outbreak in Norwalk, Ohio, of acute infectious nonbacterial gastroenteritis. Both experimentally and naturally infected individuals developed serological evidence of infection; this along with other evidence suggested that the particle was the etiological agent of Norwalk gastroenteritis.

Kardos, L.T.

Crop Response to Sewage Effluent.

In: Municipal Sewage Effluent for Irrigation. C.W. Wilson and F.E. Beckett, eds. Agricultural Engineering Department Symposium, Louisiana Polytechnic Institute, Ruston, Louisiana, 1968. pp. 21-29.

Key Words: nitrates, phosphates, agricultural sludge disposal.

Abstract:

This paper is not directly applicable to health effects, but sets constraints on applying sewage sludge at the rate of two inches in weekly intervals which translates into 129 acres required for every million gallons of effluent per day.

Kardos, L.T. and W.E. Sopper.

Effect of Land Disposal of Wastewater on Exchangeable Cations and Other Chemical Elements in the Soil.

In: Conference on Recycling Treated Municipal Wastewater Through Forest and Croplands. W.E. Sopper and L.T. Kardos eds. EPA-660/2-74-005, Pennsylvania State University, University Park, Institute for Research on Land and Water Resources, March 1974. pp. 196-203.

Key Words: chlorides, mercury, ponding/land application.

Abstract:

Changes in soil chemical quality have occurred as a result of the wastewater treatments, but these changes have been relatively small and do not appear to pose any problems for the future.

Kardos, L.T. and W. E. Sopper.

Renovation of Municipal Wastewater Through Land Disposal by Spray Irrigation.

In: Conference on Recycling Treated Municipal Wastewater Through Forest and Croplands. W.E. Sopper and L.T. Kardos eds. EPA-660/2-74-003, Pennsylvania State University, University Park, Institute for Research on Land and Water Resources, March 1974. pp.131-145.

Key Words: nitrates, phosphates, agriculture.

Abstract:

This paper does not discuss heavy metal uptake by plants but discusses rates at which applications will not permit nitrates to percolate into the groundwater. Corn rotation held nitrate levels below PHS levels for drinking water. When an entire site was occupied by corn for a period of 2 years, levels of nitrates exceeded PHS levels.

Kardos, L.T., W.E. Sopper, E.A. Myers, R.R. Parizek, and J.B. Nesbitt.

Renovation of Secondary Effluent for Reuse as a Water Resource.

EPA-660/2-74-016, Pennsylvania State University, University Park, Dept. of Agronomy, February 1974. 514 p. (Available from National Technical Information Service (NTIS) as PB-234 176.

Key Words: phosphates, chlorides, nitrates, fluorides, chlorination, crops.

Abstract:

Sprinkler application of clorinated secondary sewage effluent at levels of 1 or 2 in/wk during the growing season of year-round increased crop yields and forest tree growth except for red pine at the 2 in/wk rate. Harvested crops removed large amounts of nitrogen and phosphorus, the two key eutrophication nutrients. N and P content of forest foliage was increased but the nutrients were recycled through the litter. Only one deep monitoring well showed higher NO3 and Cl(-) concentration definitely ascribable to the effluent irrigation but still met U.S.P.H.S. drinking water standards. Recharge within one 43.5 acre site was estimated at 65 million gallons per year and resulted in lower pumping costs in two nearby University water supply wells. Data are also reported on hydrologic studies, boron studies, aeration studies, phosphorus adsorption studies and soil chemical changes.

Katzenelson, E. and B. Teltch.

Dispersion of Enteric Bacteria by Spray Irrigation.

JWPCF. 48(4):710-716. April 1976.

Key Words: coliforms, bacteria, ponding/land application, groundwater.

Abstract:

A study was undertaken to obtain data about the number and types of enteric bacteria dispersed into the air during spray irrigation with wastewater. Coliform bacteria were found in the air at a distance of 350 m downwind from the irrigation line. In one case, a Salmonella bacterium was isolated 60 m from the source of irrigation.

One of the main objectives of this work was to try to evaluate the level of danger inherent in the use of wastewater spray irrigation. Based on the findings and taking into account the rate and volume of breathing, it is possible to calculate that an individual working at a distance of 100 m from a wastewater sprinkler line will inhale approximately 36 coliform bacteria in 10 min. The longer the exposure time, the higher is the risk to the worker.

Katzenelson, E., B. Kletter, and H.I. Shuval.

Inactivation Kinetics of Viruses and Bacteria in Water by Use of Ozone.

JAWWA. 66:725-729. December 1974.

Key Words: polio virus, Escherichia coli , coliphage T2, ozonation.

Abstract:

This paper discusses bacteria and virus kills by ozone. In all cases kills were greater than 99%.

Katzenelson, E., B. Kletter, H. Schachter, and H. I. Shuval.

Inactivation of Viruses and Bacteria by Ozone.

In: Chemistry of Water Supply, Treatment, and Distribution. A.J. Rubin, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1975. pp. 409-421.

Key Words: Escherichia coli, polio virus, ozonation.

Abstract:

The inactivation kinetics of various microorganisms, which serve as indicators for water pollution, against ozone were studied. The inactivation reactor system and experimental protocol that enable ozone concentrations to remain stable in water, and reproducibility of the results, are described. Inactivation kinetics curves of poliovirus type 1, coliphage T_2, and E. coli, by various concentrations of ozone and at two different temperatures, are presented. The results clearly show the effectiveness of ozone in inactivating microorganisms. Lower concentrations of ozone and shorter contact times are required than are needed when using chlorine or any other agent presently utilized for the disinfection of water.

Kaufman, W.J.

Chemical Pollution of Ground Waters.

JAWWA. 66:152-159. March 1974.

Key Words: nitrates, DDT, chlorinated hydrocarbons, iron, nickel, cobalt, arsenic, cadmium, lead, copper, mercury, direct contact, groundwater.

Abstract:

This article reviews the movement of various contaminants in groundwater. The movement of pesticides and heavy metals appears to be related to solubilities.

Kay, K.

Inorganic Particles of Agricultural Origin.

Environmental Health Perspectives. 9:193-195. 1974.

Key Words: epidemiology, crops.

Abstract:

Speculation is offered regarding the potential health impact of the substantial quantities of inorganic particles disseminated into the environment by agricultural pest control with dry carriers. It is the talc, soapstone, and pyrophyllite, which can contain asbestos in the form of anthophyllite, tremolite, and chrysotile, which hold the potential cancer risk. Approximately 85% of all pesticides are applied by air dissemination, either dry or as a droplet spray. Pulmonary and gastric deposition of the mineral carrier will thus occur widely among pesticide application personnel, as well as among an as yet unknown fraction of the nonoccupationally exposed population in the general area around pest control operations. Ingestion of particulates deposited on food crops may be expected, as well as mineral finding its way into drinking water supplies. Studies have also shown that experimental animals exposed to both fibrous glass and nemalite (fibrous magnesium hydroxide) developed abdominal tumors: Thus, the pulmonary load and perhaps the gastrointestinal load produced by pest control with fibrous but non-asbestos-containing minerals may turn out to be carcinogenic or cocarcinogenic.

Keeney, D.R., K.W. Lee, and L.M. Walsh.

Guidelines for the Application of Wastewater Sludge to Agricultural Land in Wisconsin.

Technical Bulletin No. 88, Department of Natural Resources, Madison, Wisconsin, 1975. 36p.

Key Words: ammonia, nitrates, phosphates, copper, nickel, zinc, cadmium, protozoa, viruses, bacteria, agriculture, land reclamation, groundwater, lime treatment, stabilization.

Abstract:

In general, it appears that there is little evidence for the dissemination of disease to humans or animals by land spreading of digested sewage sludge. To insure surface water and groundwater protection from pathogenic organisms which might survive the digestion and storage period, conservation practices of avoiding runoff are recommended for the management of sludge disposal sites.

From the available data, we recommend:

1. Raw sludge should not be applied to agricultural land.

2. At least 2 feet, and preferably greater than 4 feet of soil exist between the sludge application zone and bedrock, any impermeable layer, or the water table.

3. Sludge should not be applied to soil in the year the soil is used for any root vegetables, or other vegetables that are consumed uncooked.

4. If sludge is surface applied, runoff should be minimized by use of contour strips, terraces, and border areas. Also, runoff can be reduced by injection or immediate incorporation of the sludge.

Kehr, D.

Aerobic Sludge Stabilization in Sewage Treatment Plants.

Advances in Water Pollution Research. 1966(2):143-163.

Key Words: aerobic digestion.

Abstract:

Stabilization of sludge has been carried out up to now mainly by anaerobic sludge digestion; it can also be realized by aerobic treatment. The author gives a report on the development of aerobic sludge stabilization in the German Federal Republic. There follows formal discussions of the report with additional figures and references.

Kelly, S., J. Winsser, and W. Winkelstein, Jr.

Poliomyelitis and Other Enteric Viruses in Sewage.

American Journal of Public Health. 47:72-77. January 1957.

Key Words: polio virus, coxsackie virus, epidemiology.

Abstract:

Samples of sewage from two areas in New York State were examined for viruses in parallel tests in newborn mice and tissue cultures. Poliomyelitis and Coxsackie viruses were frequently isolated during the summer and fall from both untreated and treated sewage. No correlation was noted between poliomyelitis viruses in sewage, reported paralytic cases, and socioeconomic status of the community.

The number and types of agents isolated differed according to the isolation method used. Coxsackie A viruses were isolated in mice only, poliomyelitis viruses in tissue culture only, and Coxsackie B viruses in both tissue culture and mice Coxsackie B isolations were made as frequently in mice as in tissue cultures and they were isolated more frequently in monkey kidney tissue than in HeLa cell cultures. Many mixtures of types were encountered and a few agents were unidentified.

Kenard, R.P. and R.S. Valentine.

Rapid Determination of the Presence of Enteric Bacteria in Water.

Applied Microbiology. 27(3):484-487. 1974.

Key Words: bacteria, surface water (fresh).

Abstract:

A high degree of correlation between fecal coliforms and coliphage occurred in more than 150 water samples taken over a period of several years from several different geographical areas.

With such high correlations between fecal coliform and coliphage counts, fecal coliform counts are predictable from the phage counts.

When large numbers of sensitive bacteria were added to test waters, virulent phage could be demonstrated in six to eight hours.

Kenline, P.A. and P.V. Scarpino.

Bacterial Air Pollution from Sewage Treatment Plants.

American Industrial Hygiene Association. Journal. 33:346-352. May 1972.

Key Words: bacteria, activated sludge.

Abstract:

The research reported here was undertaken to obtain data on the numbers and types of bacteria emitted into the air from activated sludge and extended aeration sewage treatment plants and to evaluate the fate of these airborne bacteria in the air. The mean bacterial emission rate was 440 bacteria per square meter per second. Volumetric concentration of the airborne bacteria was depleted primarily by atmospheric diffusion and by die-off. Deposition of the bacteria to the ground was less important. The average half-life of the bacteria was 14 seconds. Under average conditions the initial bacterial concentration was reduced by 90% at 100 feet downward at the source. Of the bacteria collected and cultured on trypticase soy agar, only 5% belonged to the Enterobacteriaceae, and these were primarily Klebsiella, Aerobacter, and Escherichia.

Kennedy, S.F., R.R. Colwell, and G.B. Chapman.

Ultrastructure of a Marine Psychrophilic Vibrio.

Canadian Journal of Microbiology. 16(11):1027-1031. May 19, 1970.

Key Words: viruses, bacteria, surface water (marine).

Abstract:

The structure of Vibrio marinus strain PS-207 was studied by both phase and electron microscopy. It was found to possess a trilaminar plasma membrane and cell wall. Membrand-bounded subunits containing DNA-like material were found dispersed throughout the cytoplasm. Giant round forms or "macrospheres" were observed in all growth stages. The size, shape, and construction of the "macrospheres" showed some variation, but could not be related to culture age. Studies of cell division in V. marinus strain PS-207 indicate the primary mechanism to be a synthesis and centripetal deposition of plasma membrane with a concomitant or subsequent synthesis and centripetal deposition of cross wall material.

Kenner, B.A. and H.P. Clark.

Detection and Enumeration of Salmonella and Pseudomonas aeruginosa.

JWPCF. 46(9):2163-2171. September 1974.

Key Words: salmonella, bacteria, epidemiology.

Abstract:

A practical laboratory method is presented for the simultaneous isolation and enumeration of Salmonella sp. and Pseudomonas aeruginosa from all classes of waters, including potable water supplies, with a minimum of interfering false positive isolations. The method allows for the testing of large volumes of high quality waters, wherein the absence of indicator bacteria (that is, total coliforms, fecal coliforms, and fecal streptococci), may give a false sense of security because of the low volumes of water usually tested. Justification for each step of the procedural method is presented.

Kerfoot, W.B. and B.T. Ketchum.

Cape Cod Waste Water Renovation and Retrieval System, a Study of Water Treatment and Conservation.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, February 1974. 67p. (Available from National Technical Information Service (NTIS) as PB-229 589).

Key Words: filtration, nitrification/denitrification, surface water (fresh), crops.

Abstract:

The Cape Cod Wastewater Renovation and Retrieval System strives to evaluate alternative means of wastewater treatment and develop design criteria for the recharge of water of potable quality to the groundwater reservoir of the coastal outwash plains of Cape Cod and the Islands. The three-year plan involves investigation of the in situ performance of (1) the existing sand filter bed at Otis Air Force Base, (2) a rapid infiltration system designed to enhance biological denitrification, and (3) a spray irrigation-cropping program. The quantity and quality of the treated water, the receiving water, and the character of the soil is being carefully examined to project eventual water condition after many years of operation.

Kerfoot, W.B. and S.A. Jacobs.

Permissible Levels of Heavy Metals in Secondary Effluent for Use in a Combined Sewage Treatment-Marine Aquaculture System. I: Monitoring During Pilot Operation.

In: Wastewater Use in the Production of Food and Fiber - Proceedings. EPA-660/2-74-41, U.S. Environmental Protection Agency, Washington, D.C., Office of Research and Development, June 1974. pp. 65-78.

Key Words: cadmium, chromium, copper, lead, nickel, zinc, shellfish.

Abstract:
The 102-day study indicates that oysters can be cultured with the use of secondary effluent as a substitute fertilizer without raising the danger of metal contamination. While other potential contaminants, including pathogens and organic compounds, need further investigation to evaluate the advisability of substituting secondary effluent for artificial media in aquaculture, the initial results suggest that the inherent elevated metal concentrations in domestic wastewater do not appear to pose a threat to shellfish culture if effluent of a principally domestic source is used.

Kerfoot, W.B. and G.A. Redmann.

Permissible Levels of Heavy Metals in Secondary Effluent for Use in a Combined Sewage Treatment-Marine Aquaculture System. II: Development of Guidelines by Method of Additions.

In: Wastewater Use in the Production of Food and Fiber - Proceedings. EPA-660/2-74-041, U.S. Environmental Protection Agency, Washington, D.C., Office of Research and Development, June 1974. pp. 79-99.

Key Words: copper, cadmium, chromium, lead, nickel, zinc, shellfish.

Abstract:

The final permissible level suggested as a guideline was taken to be the lowest value occurring in the column for each metal. Effluent containing a concentration of metal in solution above or at this level is not recommended for aquacultural purposes. In three cases, Cr, Pb, and Zn, the suggested level represented the concentration toxic to algae. For copper, the level was based on acute toxicity to humans. Oddly, nickel was the only element whose recommended concentration in the effluent was based on alert levels, representing a level three standard deviations above that normally found.

Even though the levels of metal in the effluent for use in the aquaculture system were calculated against standards suggested for food regulations, many questions are left unanswered as to whether consumption of the shellfish is completely safe from a public health point of view, considering only metals. Total metal content may be misleading since the structure of the compound is not elucidated. Organometallic species of metals may be present in effluent due to industrial discharge or possible reactions encountered during the sewage treatment process. These compounds, if present, may have toxic effects not commonly associated with their inorganic counterparts. Also, the possible carcinogenic, mutagenic, and teratogenic effects were not considered here and should be investigated.

Ketchum, B.H.

Ecological Effects of Sewage Sludge Disposal at Sea.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

Key Words: chromium, lead, parasitic worms, surface water (marine).

Abstract:
This is a good general discussion on sewage sludge disposal to sea due to industrial discharge or possible reactions.

Ketchum, L.H., Jr. and W.J. Weber, Jr.

Coagulation of Stormwaters and Low Alkalinity Wastewaters.

JWPCF. 46(1):53-62. January 1974.

Key Words: suspended solids, chemical treatment, combined municipal and/or industrial systems.

Abstract:

The chemical combination of lime and activated silica proved effective in clarifying low alkalinity wastewaters. The upper limit of alkalinity where activated silica demonstrates up to 10-fold lime reduction is about 50 mg/l as $CaCO_3$. Natural waters low in alkalinity are also usually low in hardness. In the synthetic systems studied, alkalinity was added in the form of sodium bicarbonate; therefore, even the high alkalinity systems contained essentially no hardness. Hardness, therefore, is not the cause of the loss of effectiveness of activated silica in reducing lime requirements for treating high alkalinity wastes.

Kier, L.D., E. Yamasaki, and B.N. Ames.

Detection of Mutagenic Activity in Cigarette Smoke Condensates.

Proceedings National Academy of Sciences. 71(10):4159-4163. October 1974.

Key Words: epidemiology.

Abstract:

This article describes the application of the Ames Test for the detection of the presence of mutagenic compounds in the smoke condensates of cigarettes.

King, L.D. and H.D. Morris.

Land Disposal of Liquid Sewage Sludge. II. The Effect of Soil pH, Manganese, Zinc, and Growth and Chemical Composition of Rye (*Secale* *caeeale* L.)

Journal of Environmental Quality. 1:425-429. April 1972.

Key Words: manganese, zinc, groundwater.

Abstract:

Rye was seeded in October 1969 and 1970 in a Coastal bermudagrass (*Cynodon* *dactylon* *L. Pers.*) sod on Cecil sandy clay loam to determine the residual effect of four rates of liquid sewage sludge and one chemical fertilizer treatment applied the previous summer. Sludge rates of 0.63, 1.25, 2.5, and 5.0 cm were applied in such a manner as to supply 4.4, 8.8, 10, and 20 cm of sludge, respectively, in 1969 and 2.5, 5.0, 10 and 20 cm, respectively, in 1970. Chemical fertilizer supplied 224-37-93 kg/ha of NPK in 1969 and 358-112-224 in 1970. The chemical fertilizer plots also received 56-25-47 kg/ha of NPK in October when the rye was planted and 84 kg/ha of N the following February. Soil and the accumulated sludge crust were sampled and lime (6.7 metric tons/ha)applied as a split plot treatment just prior to planting rye in 1970.

Sludge treatments decreased soil pH and increased exchangeable and water-soluble Mn and exchangeable Zn in the soil. Up to 29 kg/ha of exchangeable and 12.7 kg/ha of water-soluble Zn was found in the sludge crust. In 1969-70 and at the zero lime rate in 1970-71 maximum rye yields were obtained with chemical fertilizer and the 1.25- and 2.5-cm rate. With lime there were no significant differences among the 0.63-, 1.25-, and 2.5-cm rates and chemical fertilizer. In 1969-70 and at both lime rates in 1970-71 yields were reduced by the 5-cm rate as compared to the 1.25- and 2.5-cm rates. Significant yield increases due to liming occurred at the 5-cm rate only. Reduced yields at the 5-cm rate were probably due to high forage levels of Zn and possibly Cu rather than deficiencies of N, P, K, Ca, or Mg or high levels of Mn, B, Mo, or Al.

King, L.D. and H.D. Morris.

Land Disposal of Liquid Sewage Sludge. III. The Effect on Soil Nitrate.

Journal of Environmental Quality. 1:442-446. April 1972.

Key Words: ammonia, nitrates, groundwater.

Abstract:

A field experiment was conducted over a 2-year period to determine the effect of liquid sewage sludge on soil nitrate content of a Cecil sandy clay loam (*Typic Hapludults*) to a 120 cm depth. Periodic applications of four rates of sludge to coastal bermudagrass (*Cynodon dactylon L. Pers.*) supplied a total of 4.4, 8.8, 10.0 and 20.0 cm of sludge in 1969 and 2.5, 5.0, 10.0 and 20.0 cm in 1970. Respective amounts of N applied by the four rates were 1,037, 2,074, 2,580, and 5,160 kg/ha in 1969 and 492, 984, 1,970, and 3,940 kg/ha in 1970. A chemical fertilizer treatment supplied 364 kg/ha of N in 1969 and 489 kg/ha in 1970. The two highest sludge rates affected significant increases in soil nitrate in the 0 to 120 cm profile. The other two sludge rates and the chemical fertilizer treatment did not increase soil nitrate and were deemed safe from the standpoint of potential groundwater pollution. At the 20 cm rate 40% (287 kg/ha) of the NO_3-N present in the 0 to 120 cm profile in October 1970 could not be accounted for the following May. Of the N supplied by the 10 and 20 cm applications, 17 and 9%, respectively, was recovered through crop uptake while 56 and 54% remained in the sludge crust that had accumulated on the soil surface.

King, L.D. and H.D. Morris.

Nitrogen Movement Resulting from Surface Application of Liquid Sewage Sludge.

Journal of Environmental Quality. 3(3):238-242. July 1974.

Key Words: ammonia, nitrates, nitrites, groundwater.

Abstract:

One of the factors limiting the rate at which sewage sludge can be applied to soil is the speed at which inorganic N is formed and the fate of that inorganic N. A greenhouse lysimeter study was initiated in order to quantify some of the sinks into which N from sludge applications might move. For 12 weeks soil columns were treated at 3-week intervals with a surface application of 2.5 cm of liquid sewage sludge. During each 3-day interval 2.5 cm of water was applied to: (i) soil receiving no sludge (Soil-2.5), (ii) soil receiving sludge (Sludge-2.5), and (iii) soil planted to Coastal Bermudagrass (*Cynodon dactylon* L. Pers receiving sludge (Grass-2.5). Five centimeters of water was added to soil + grass + sludge (Sludge-5) during each 3-day interval. Another treatment was used to encourage a nitrification-denitrification cycle. This treatment (Grass-F) was identical to Grass-2.5 except that during each third week sufficient water was added to bring the 3-week total to the same as that in Grass-5. Provisions were made to collect the leachate for NO_3-N analysis and to measure NH_3 volatilization from the sludge.

The average loss of N as NH_3 was 36% of the applied NH_4-N in the Soil-2.5 treatment and 24% in the three grass treatments. This represented 4.9 and 3.3%, respectively, of the total N applied. The Grass-5 treatment resulted in the maximum NO_3-N leaching loss (5.4% of the applied N). The Grass-F treatment did not result in reduced NO_3-N leaching. Grass removed 10.3% of the applied N. From 52 to 64% of the applied N remained in the sludge crust on the soil surface.

King, P.H., H.H. Yeh, P.S. Warren, and C.W. Randall.

Distribution of Pesticides in Surface Waters.

JAWWA. 61(9):483-486. September 1969.

Key Words: organophosphorus pesticides, chlorinated hydrocarbons, surface water (fresh).

Abstract:

The range of distribution data noted from the reported studies is summarized in this article. In general, a high-clay soil was shown to adsorb about twice the amount of pesticide per unit weight of soil as a sandy soil. The uptake by the algal systems was approximately one order of magnitude greater than by the soils. This uptake was also noteworthy in that, in contrast to the soil systems, it did not decrease proportionately with increasing pesticide concentrations. The uptake by the algae illustrates one possible means by which pesticides may be introduced into the food chain and thus eventually be concentrated in higher animals, such as fish.

The use of controlled algae ponds for nutrient removal from irrigation return water has been suggested as a possibility for solution of problems leading to eutrophication. If such waters contain significant amounts of synthetic organic pesticides, the uptake of these pesticides by the algae, as indicated by the reported data, may be sufficient to negate the use of the harvested algae for animal feed.

The data for sorption of pesticides by coal and by activated carbon illustrate possible means of removing these pesticides from solution. Coal is 2-2½ order of magnitude superior to soil in adsorbing parathion. However, it is ineffective relative to activated carbon. Activated carbon is about 4 orders of magnitude greater in ability to sorb parathion than is soil. Coal used as one component in a multimedia filter may, however, significantly increase pesticide removal, especially if the grade of coal is selected that will result in maximum uptake. Activated carbon remains as a superior adsorbent for pesticides. Its ability to remove trace quantities of these materials is well known and is confirmed by the reported data.

Kinman, R.N.

Ozone in Water Disinfection.

In: Ozone in Water and Wastewater Treatment. F.L. Evans, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1972. pp. 123-143.

Key Words: *Escherichia coli*, salmonella, coliforms, COD, bacteria, fecal streptococci, ozonation.

Abstract:

Ozone has been shown to be a powerful disinfecting agent for either water or wastewater applications. A significant residual ozone concentration does not guarantee that a water is safe to drink. Organic solids may protect organisms from the disinfecting action of ozone and increase the demand for ozone. Ozone residuals cannot be maintained in metallic distribution systems for very long. The inability to maintain an ozone residual in water distribution systems is the principal reason ozone is not more widely used for water disinfection in this country and the principal reason for its use as a pretreatment in those water treatment plants where it is in use.

Kinoshita, S. and T. Sunada.

On the Treatment of Polychlorinated Biphenyl in Water by Ionizing Radiation.

Advances in Wastewater Research. Pergamon Press, New York. C/13/26/1-6. 1972.

Key Words: chlorinated hydrocarbons, chemical treatment, adsorption/ion exchange,

Abstract:

PCB in aqueous microparticulate colloidal solution is destroyed by ionizing radiation, but its resistance to radiation is far more than other chlorinated hydrocarbons such as pentachlorophenol (3) or DDT (7) and other pesticides such as parathion (2). This may seem to be a weakness in using radiation treatment for polluted water, but the proposed radiation treatment generally consists of several procedures such as irradiation, sedimentation by coagulation, filtration and postchlorination. Conventional treatment by sedimentation with coagulation can so effectively treat PCB in water that the proposed radiation treatment would result in thorough removal. Acute toxicity of irradiated PCB solution is found to be far less than the non-irradiated solution for striped shrimps, and the products of irradiation show reduced toxicity.

Kirk, B.S., R. McNabney, and C.S. Wynn.

Pilot Plant Studies of Tertiary Wastewater Treatment With Ozone.

In: Ozone in Water and Wastewater Treatment, F.L. Evans, ed.
Ann Arbor Science Publishers, Ann Arbor, Michigan, 1972.
pp. 61-82.

Key Words: BOD, ammonia, nitrites, bacteria, ozonation.

Abstract:

All of the results presented in this article are preliminary and are subject to revision. Because of the interim nature of the material presented, it is inappropriate to present firm conclusions since they, likewise, could be subject to revision. Instead, a simple summary and a present estimate of this study is given.

A pilot plant for the tertiary treatment of wastewater with ozone has been described here. It has been operated on feed water subjected to a variety of secondary and tertiary pretreatments.

The COD reduction rate is rapid in the first stages of treatment but slows down drastically in the latter stages after 50-70% of the COD has been removed. However, if treatment is continued long enough, practically all of the COD can be oxidized by ozone.

The pH of the wastewater changes toward neutrality during ozone treatment. Generally the higher pH feed waters show a faster COD reduction.

At least for the IPC pretreated feed water, the ozone consumption in the first stage is less than the expected 3 lb O_3/lb COD removed. In the latter stages, the ozone consumption is substantially greater. However, because most of the COD is removed in the first stage, the average ozone consumption is still less than 3 lb O_3/lb COD removed.

For the limited cases correlated so far, the log of both the first order and second order reaction rate constants appear linear with percent COD removal, and both decrease by roughly a factor of ten during treatment.

The oxidation of nitrogenous material to nitrates during ozone treatment is significant only at high pH.

Major reductions of turbidity have been realized on all plant feeds, and the ozone tertiary treatment, as expected, produces complete bacteria kills.

It is evident that pump and compressor power requirements are not insignificant compared to ozone generation power requirements.

In overall summary, the pilot plant has generally met design expectation in its operations.

Kirkham, M.B.

Trace Elements in Corn Grown on Long-Term Sludge Disposal Site.

Environmental Science and Technology. 9:765-768. August 1975.

Key Words: aluminum, cadmium, copper, iron, manganese, nickel, lead, zinc, crops.

Abstract:

Corn plants (*Zea mays L.*) grown on soil treated with municipal sludge (28 metric tons/ha/yr) for 35 years were analyzed for Al, Cd, Cu, Fe, Mn, Ni, Pb, and Zn. Soil was analyzed to the 91 cm (36 in) depth for total and dilute acid extractable concentrations of the trace elements. Total concentrations of the trace elements in the 0 to 30 cm (0 to 12 in) depth of soil were increased by sludge additions by the following factors: Al, 1.1; Cd, 35; Cu, 16.5; Fe, 1.1; Mn, 1.2; Ni, 2; Pb, 16.5; Zn, 13. The results indicated that, even though large amounts of trace elements accumulated in the soil, these elements did not accumulate appreciably in the grain of the corn plants when compared with the accumulation in the control crop and normal levels reported in the literature. The roots, however, contained large amounts of the elements. Concentrations of Cd and Cu in the leaves were higher than normal concentration ranges.

Kirkham, M.B. and G.K. Dotson.

Growth of Barley Irrigated with Wastewater Sludge Containing Phosphate Precipitants.

In: Municipal Sludge Management; Proceedings of the National Conference on Municipal Sludge Management, 1974. pp. 97-106.

Key Words: phosphates, COD, ammonia, nitrates, nitrites, aluminum, stabilization, crops, chemical treatment, lime treatment, effluent characteristics.

Abstract:

Barley (Hordeum vulgare L., var. Bearded), grown for 16 weeks in pots of loam soil, was irrigated for seven weeks with wet sludges containing precipitated phosphates to see if chemically-treated sludges could be used agriculturally. Raw primary sludge and primary sludges from alum and ferric chloride addition to raw wastewater, each either limed or unlimed, were added at two different rates, corresponding to a total application of 23 or 46 m tons/ha/yr. The elemental composition of the plants and the total and extractable phosphorus in the soil were determined. The results showed that barley plants irrigated with the three types of sludges grew as well as those supplied with inorganic fertilizer. Fertilized plants, however, yielded more grain than sludge-treated plants. Slight variations in nutrient content of the sludge-treated plants appear to be due to differences in the concentration and availability of the elements in the soil. Differences in total soil phosphorus among the treatments were not significant. The limed and unlimed alum-treated soils and the unlimed iron-treated soil had significantly more extractable phosphorus. Liming significantly decreased extractable phosphorus only in the iron-treated soil. Ninety-two percent of the phosphorus added by the sludges was still in the sludge crust at the end of the experiment. The results demonstrated that the presence of phosphate precipitated by Al or Fe did not limit growth, and that sludges containing phosphate precipitants can be used, at least on a short-term basis, to grow barley.

Kleerekoper, H.

Effects of Copper on the Locomotor Orientation of Fish.

EPA-R3-73-045, Texas A & M University, College Station,
Dept. of Biology, June 1973. 97p. (Available from
National Technical Information Service (NTIS) as PB-222 596).

Key Words: copper, fish.

Abstract:

In some species of fish the locomotor response to subacute concentrations of copper ions results in changes in orientation. The net result of these changes may be "attraction" or "avoidance", orientation towards copper-containing zones of water. The evidence indicates that the direction of the orientation is relatively independent of the maximum concentration of the metal but is determinded particularly by the gradient of copper ions as the fish pass from laboratory water to copper ion containing water. A shallow gradient leading to the zones of maximum copper concentration elicits a clear "attraction", a medium steep gradient decreases that response somewhat, and a steep gradient results in significant "avoidance". However, in the latter condition, highly significant "attraction" is again obtained when a temperature rise of .4C is associated with the copper ion. Copper and temperature interact to elicit orientation response not produced by either copper alone or temperature alone. Responses of this type can only be assessed through detailed monitoring of locomotor characteristics and careful data analysis.

Klein, L.A., M. Lang, N. Nash, and S.L. Kirschner.

Sources of Metal in New York City Wastewater.

Metal Finishing. 72:34-35. July 1974.

Key Words: copper, chromium, nickel, zinc, cadmium, combined municipal and/or industrial systems.

Abstract:
This paper discusses heavy metal sources for municipal wastewater.

Klein, S.A.

NTA Removal in Septic Tank and Oxidation Pond Systems.

JWPCF. 46(1):78-88. January 1974.

Key Words: synthetic/organics, anaerobic digestion, ponding/land application, direct contact, groundwater.

Abstract:

1. Removal of NTA averaged 21.8, 23.3, and 23.1 percent in three septic tanks during the nine months of operation.

2. In the percolation fields, 5 to 7 wk were required for biological slimes to develop and become acclimated to NTA.

3. Aerobic percolation fields (normal operation) degraded essentially all of the NTA from influents containing concentrations up to 60 mg/l.

4. Totally anaerobic fields degraded only 10 percent NTA, but under nearly anaerobic conditions (DO concentration of less than 0.5 mg/l) NTA degradation was virtually 100 percent.

5. The presence of NTA had no noticeable effect on performance of septic tank percolation fields or sewage treatment systems.

6. In aerobic soil columns, NTA was nearly 95 percent degraded from influent concentrations of 40 and 100 mg/l.

7. In anaerobic (saturated) soil columns, degradation ranged from 10 to 15 percent for the three influent NTA concentrations examined (10, 40, and 100 mg/l).

8. In oxidation ponds, after a 2-month acclimation period, steady state removal of NTA was in excess of 90 percent when influent concentrations were in the range normally expected in wastewater (up to 30 mg/l).

9. At NTA concentrations up to 75 mg/l in wastewater fed to oxidation ponds, bio-degradation remained in excess of 80 percent, but at 100 mg/l NTA removal declined to about 50 percent.

10. Degradation of NTA in anaerobic digestion ranged from 8.0 to 13.6 percent in digesters fed concentrations of 15 to 60 mg/l NTA.

Klein, S.A., D. Jenkins, R.J. Wagenet, J.W. Biggar, and M.S. Yang.

An Evaluation of the Accumulation, Translocation, and Degradation of Pesticides at Land Wastewater Disposal Sites.

University of California, Berkeley, Sanitary Engineering Research Laboratory, November 1974. 235p. (Available from National Technical Information Service (NTIS) as AD-A006 551).

Key Words: chlorinated hydrocarbons, ponding/land application.

Abstract:

No significant accumulation of biocides throughout the depths of the lysimeters was detected during the study. The pesticide Diazinon was present usually at soil concentrations of on the order of up to several μg/kg (dry soil basis) in some soils. Soil concentrations of biocides appeared to be greatest in the very surface zones. No evidence of biocide transport as a result of any of the imposed operational changes was detected.

Travel of biocides with soil water was generally sporadic and low concentrations on the order of several μg/ℓ were observed on occasion in the soil column effluents and at various depths in the soil columns. Quite rare instances of high concentrations of biocide movement were noted, but could not be correlated to any imposed operational change or existing operational mode.

The mineral quality of the effluents from the lysimeters in general appeared to be more a function of the soil type and the conditions existing in the soil column (especially the moisture content) rather than a function of the nature of the applied wastewater.

Kleopfer, R.D. and B.J. Fairless.

Characterization of Organic Components in a Municipal Water Supply.

Environmental Science and Technology. 6(12):1036-1037. November 1972.

Key Words: synthetic/organics, drinking and recreational water.

Abstract:

The Evansville, Ind., municipal drinking water, which is taken from the Ohio River, was analyzed for organic components using carbon filter techniques. Over 40 organic compounds were detected using flame ionization gas chromatography. Thirteen of those compounds were identified with the aid of a gas chromatograph coupled with a mass spectrometer. The probable source of a major organic contaminant - bis(2-chloroisopropyl)-ether - was found to be an industrial outfall located about 150 river miles upstream from the Evansville water intake. The concentration of bis(2-chloroisopropyl)-ether in the Ohio River at Evansville was about twice that found in the municipal drinking water.

Klock, J.W.

Survival of Coliform Bacteria in Wastewater Treatment Lagoons.

JWPCF. 43(10):2071-2083. October 1971.

Key Words: bacteria, salmonella, *Vibrio cholerae*, coliforms, aerated lagoons, anaerobic lagoons, trickling filter, activated sludge, gravity separators, anaerobic digestion.

Abstract:

An experimental lagoon was used as a field laboratory to examine the sequence of biochemical events that normally occur in the treatment of raw wastewater. Coliform most probable number determinations were performed using the dilution tube technique described in "Standard Methods." An Arrhenius plot is presented of coliform survival rate constants as a function of Eh and temperature for various natural waters and nonsedimentary wastewater treatment processes at a constant pH of 7.5.

Kluesener, J.W. and G.F. Lee.

Nutrient Loading from a Separate Storm Sewer in Madison, Wisconsin.

JWPCF. 46(5):920-936. May 1974.

Key Words: ammonia, nitrates, phosphates, combined municipal and/or storm systems.

Abstract:

1. In general, approximately 15 percent of the rainfall on the Manitou Way basin appears as surface runoff from the basin. The percent runoff was approximately equivalent to the area of the basin covered by streets. For any particular storm, percent runoff varied as a function of rainfall amount.

2. Nutrient and SS concentrations were usually greatest during the early stages of the runoff event, decreasing with time. Phosphorus concentrations were greatest in spring and fall, whereas nitrogen concentrations were greatest in the spring.

3. Rainfall seemed to be the major source of inorganic-N in runoff from the urban area. Phosphorus generally resulted from accumulated litter and possible automotive exhaust discharged to the streets.

4. Barring the availability of a suitable flow-proportioned sampler, the next most appropriate sampling procedure would be to characterize the particular basin by collecting flow and chemical data over fairly short time intervals for several storms. Samples should continue to be collected over the same short time intervals, but the flow data and historical relationship between flow and concentration should be used judiciously to select an appropriate number of samples for chemical analyses.

5. Urban runoff data from the Manitou Way basin as extrapolated to the entire Lake Wingra basin indicated that approximately 80 percent of the total phosphorus and about 35 to 40 percent of the total nitrogen influent to Lake Wingra arises from urban runoff.

Knapp, C.E.

Mercury in the Environment.

Environmental Science and Technology. 4(11):890-892.
November 1970.

Key Word : mercury.

Abstract:

Both man and nature share the responsibility for mercury production. In the natural environment mercury is found in soil, air, and water. Monitoring and analysis throughout the country now show that mercury is present in amounts deemed excessive in all realms of the environment.

Mercury is cumulative and, once it is in the system, it is only slowly discharged. Accumulation of excess mercury can result in disastrous situations.

Mercury is more serious than DDT and less serious than nuclear testing. Although an increasing amount of mercury has been discovered in foods, there is no reason to declare a public health crisis; the situation is potentially dangerous and requires study.

The articles go into some detail about forms of mercury, methylation, hazards, sources and analysis.

Knezevic, M.V. and K.Y. Chen.

Organo-Metallic Interactions in Recent Marine Sediments.

University of Southern California, Los Angeles, 1975.

Key Words: aluminum, arsenic, cadmium, chromium, copper, iron, manganese, nickel, lead, zinc, total organic carbon, surface water (marine).

Abstract:

Availability of trace metals to biota at the interfaces between seawater and solid sediments is affected by organo-metallic interactions; the organic substances and seawater may solubilize the insoluble forms of trace metals attached to the solid surfaces through chelation. In the case of soils, the migration and accumulation of trace metals has been found to be associated with the presence of humic substances. The different functional groups present in humic substances appear to be responsible for the organo-metallic complexing phenomena. In this study, efforts were made to determine whether such relationships also exist in nearshore recent marine sediments. (Humic substances have been shown to be a major component of the organic material in recent marine sediments).

Knight, H.T. and L.J. Olsen.

Mercury Distribution in American Smelt from Lake Michigan.

American Midland Naturalist. 91(2):451-452. April 1974.

Key Words: mercury, fish.

Abstract:
This article establishes mercurial levels for freshwater fish.

Knittel, M.D.

Occurrence of _Klebsiella_ _pneumoniae_ in Surface Waters.

Applied Microbiology. 29(5):595-597. May 1975.

Key Words: coliforms, fecal streptococci, _Escherichia_ _coli_, surface water (fresh).

Abstract:
The occurrence of _Klebsiella_ _pneumoniae_ in surface waters was not found to be ubiquitous. When it was isolated, _Escherichia_ _coli_ could also be found. The fecal coliform to fecal streptococci ratio suggest that its origin could be human, animal, or mixed sources.

Knittel, M.D.

Taxonomy of Klebsiella Pneumoniae Isolated from Pulp/Paper Mill Wastewaters.

EPA-660/2-75-024, Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon, June 1975. 39p. (Available from National Technical Information Service (NTIS) as PB-244 405).

Key Words: coliforms, epidemiology.

Abstract:

The coliforms in the wastewater from pulp and paper mills are composed of as much as 80 percent *K. pneumoniae*.

Kobayashi, J.

Relation Between the "Itai-Itai" Disease and the Pollution of River Water by Cadmium from a Mine.

Advances in Water Pollution Research. 1970. (1):I-25/1-8.

Key Words: cadmium, lead, zinc, surface water (fresh), groundwater.

Abstract:

As a consequence of the discovery of a high content of Cd, Zn, and Pb in the tissues of the patients suffering from the itai-itai disease, which appeared in a restricted district along the Jintsu River in Toyama Prefecture, Japan, there was a strong presumption that the cause of the disease was chronic poisoning by the heavy metals found in the wastewater from a mine. The following observations were made: (1) The itai-itai disease and damage to rice plants by the wastewater appeared in the same place along the banks of the river during the same period, and decreased at the same time; (2) A heavy accumulation of Cd and other metals was found in the patients' bones, internal organs, soil, and plants; (3) In animal experiments each of the rats was kept in a metabolism test cage, excrement and urine were collected weekly, and Ca was quantitatively determined. The group of rats which was fed Cd excreted more Ca than that assimilated from the feed, while the control group showed the contrary phenomenon. Thus, the loss of mineral components from the bones was ascertained to be caused by Cd; (4) Research on the existence of a similar disease was conducted on Tsushima Island of Nagasaki Prefecture.

From these results, it was made clear that the itai-itai disease was induced by cadmium in the wastewater from a mine.

Koeman, J.H., W.H.M. Peeters, C.H.M. Koudstaal-Hol, P.S. Tijoe, and J.J.M. de Goeij.

Mercury-Selenium Correlations in Marine Mammals.

Nature. 245:385-386. October 1973.

Key Words: mercury, selenium.

Abstract:

This paper draws a correlation between mercurial selenial uptake in the liver of marine mammals. There may be a similar correlation in man.

Koirtyohann, S.R., R. Meers, and L.K. Graham.

Mercury Levels in Fishes from Some Missouri Lakes with and without Known Mercury Pollution.

Environmental Research. 8:1-11. August 1974.

Key Words: mercury, surface water (fresh).

Abstract:

Mercurial fungicides used in golf greens maintenance can lead to elevated levels of mercury in fish, from lakes receiving greens drainage. Of the species tested, the largemouth bass was the most sensitive indicator with levels ranging from 1 to 7 µg Hg/g of wet tissue in fish taken from lakes which receive drainage from treated greens. Background mercury levels in largemouth bass from impoundments in central Missouri are 0.1-1.2 ppm depending on size and other factors. Many lakes with no known source of mercury contamination produce bass which contain significantly more than 0.5 ppm of mercury.

Kokoropoulos, P.

Designing Post-Chlorination by Chemical Reactor Approach.

JWPCF. 45(10):2155-2165. October 1973.

Key Words: manganese, iron, ammonia, nitrites, coliforms, chlorination.

Abstract:
The article is concerned with the rates of the reactions of HOCl with ammonia, organic nitrogenous and aromatic compounds, inorganic reducing species and detergents as they affect the disinfection process. But the information in the article may be useful, since these rates determine the amounts of the contaminants remaining in wastewater. This article also mentions the formation of toxic chlorinated compounds and says there is no information on potential long-term health effects induced by continuous low-level injection of chlorinated nitrogenous compounds.

Kokoropoulos, P. and G.P. Manos.

Kinetics as Design Criteria for Post Chlorination.

Journal of the Environmental Engineering Division, ASCE.
99(EE1):73-88. February 1973.

Key Words: manganese, iron, ammonia, nitrites, coliforms, chlorination.

Abstract:
Post chlorination is a series of chemical reactions in solution under flow conditions. It is controlled by the rates of reactions of the various impurities of an effluent, including microorganisms, with hypochlorous acid and hypochlorite ion. Aquisition of adequate kinetic data and their application, as design criteria, to the design of postchlorination facilities, will lead to the development of facilities with improved efficiency and lower cost. Proper interpretation and application of kinetic data indicate that adequate free chlorine residuals may exist without reaching to extreme situations such as break point chlorination. Along with the volume of effluent to be treated and the desired or required chlorine residual, the composition of the effluent with respect to components capable of reacting with chlorine and their respective reaction rate constants should be considered as primary design criteria for post chlorination.

Specific rate constants, k_i, of the reactions of chlorine with effluent components are derived (for ammonia, coliform bacteria, amoebic cysts, nitrite, manganese, iron, detergents). The effect of the reaction rate constants, k_i, on the ratio of the initial concentration of these components to the final concentration is given for an experimental situation. Examination of the effluents at Akron and Barberton, Ohio, indicated that a significant amount of chlorine reacted with anionic surface agents.

Kolata, G.B.

Chemical Carcinogens: Industry Adopts Controversial "Quick" Tests.

Science. 192:1215-1217. June 18, 1976.

Key Words: salmonella, epidemiology.

Abstract:
This article discusses the Ames Test and is based on the presumption that many cancers are related to mutations or some sort of damage to the DNA of a cell and, therefore, that agents that are mutagenic are likely to be carcinogenic. Salmonella typhimurium were used.

Koon, J.H. and W.J. Kaufman.

Ammonia Removal from Municipal Wastewaters by Ion Exchange.

JWPCF. 47(3):448-465. March 1975.

Key Words: ammonia, adsorption/ion exchange.

Abstract:

The principal objective of this investigation was to optimize the application of the zeolite ion exchanger clinoptilolite to the removal of ammonia from wastewaters and to relate the findings to the design and cost of this process. The major conclusions of the investigation are summarized below:

1. The ammonium exchange capacity of clinoptilolite in treating domestic wastewaters may be estimated from the cationic strength (similar to total ionic strength) of the column influent. The ammonium exchange capacity was observed to decrease sharply with increasing competing cation concentrations to a cationic strength of about 0.01 moles/l. Increases of cationic strength above this value continued to decrease the exchange capacity, but to a much lesser degree. The results of these tests may be used to estimate the ammonium exchange capacity of clinoptilolite for wastewaters containing cation concentrations that are not unusually different from concentrations used in these tests.

2. While the total ammonium exchange capacity was identical for Na- and Ca- clinoptilolite, the breakthrough capacity was more than twice as great for Na-clinoptilolite. This observation was explained by the greater mobility of the smaller sodium ion in the zeolite pores. In addition, regeneration with calcium salts was much less efficient than with sodium salts. Approximately three times as much regenerant, on an equivalent basis, was required for complete ammonia elution with $CaCl_2$ and $Ca(OH)_2$ in comparison with NaCl and NaOH. Operation of clinoptilolite by using sodium salts for regeneration resulted in a greater throughput per cycle to ammonia breakthrough and led to economies of regeneration.

3. Optimum conditions for ammonia exchange exist between pH 4.0 and 8.0, with little variation in ammonium exchange capacities between these values. However, the ammonium exchange capacity decreased rapidly outside this range.

4. The pH at which clinoptilolite was regenerated affected both the volume of regenerant required and regeneration efficiency, regeneration at pH 12.5 being more effective and more efficient than regeneration at pH 11.5 or 12.0. However, the results of attrition studies showed that the strength of caustic used for regeneration will be limited by the instability of clinoptilolite in caustic solutions.

5. Increasing the regenerant NaCl concentration beyond a certain value at a particular pH had no effect on the volume of regenerant required. For regeneration at pH 12.0 and 12.5, no benefit was realized by using a salt concentration greater than 12 g NaCl/l. Likewise, increasing the salt concentration beyond 20 g NaCl/l at pH 11.5 produced no improvement in regeneration performance.

6. Process demonstration studies conducted at three test locations showed that an average effluent ammonia concentration of 0.75 mg/l NH_3-N could be achieved for runs of 120 to 180 BV duration at flows of 10 to 15 BV/hr.

7. The total cost of ammonia removal with clinoptilolite for a 10 mgd (38,000 cu m/day) plant was estimated to be $0.163/1,000 gal ($0.042/cu m) for cases in which regenerant is used only once and $0.101/1,000 gal ($0.027/cu m) when regenerant is reused. Costs for disposal of spent regenerant solutions were not included in the cost estimate for the case in which regenerant would be wasted after one use. These costs indicate that the reuse of regenerant by air stripping ammonia from the spent regenerant solution will be the most feasible method of operation. However, in areas in which transportation charges for chemicals are minimal and disposal of regenerant solutions may be easily accomplished, wasting of regenerant solutions after one use might be competitive with treatment costs when regenerant is reused.

Kopfler, F.C.

The Accumulation of Organic and Inorganic Mercury Compounds by the Eastern Oyster (Crassostrea virginica).

Bulletin of Environmental Contamination and Toxicology. 11:275-280. March 1974.

Key Words: mercury, shellfish.

Abstract:

This article investigates uptake by oysters of the various forms of mercury (inorganic, phenyl- and methyl-mercury).

Kopfler, F.C. and J. Mayer.

Concentrations of Five Trace Metals in the Waters and Oysters (Crassostrea Virginica) of Mobile Bay, Alabama.

Proceedings National Shellfisheries Association. 63:27-34. June 1973.

Key Words: cadmium, chromium, copper, lead, zinc, shellfish.

Abstract:

From January 1968 through June 1969, samples of water and oysters were collected at monthly intervals from eight locations in Mobile Bay, Alabama. These samples were analyzed for cadmium, chromium, copper, lead and zinc by atomic absorption spectrophotometry and the results analyzed statistically.

Oysters from Mobile Bay contained less cadmium, copper, and zinc than the average concentrations reported for Atlantic Coast oysters. The concentration of chromium was approximately the same while the lead concentration was about two times that of the average value for Atlantic Coast oysters.

Oysters collected from the western side of the Bay were found to contain a significantly greater concentration of copper and zinc than oysters collected from the eastern side. These differences were attributed to differences in river systems that contribute the fresh water discharge and runoff to opposite sides of the Bay.

Although concentrations of the trace metals investigated were 10^3 - 10^5 higher in oysters than the concentrations in the environmental water samples, poor correlation was observed between the two sets of data.

Kopp, J.F.

The Occurrence of Trace Elements in Water.

In: Proceedings of the Third Annual Conference on Trace Substances in Environmental Health. D.D. Hemphill, ed. University of Missouri, Columbia, 1969. pp.59-73.

Key Words: zinc, iron, copper, manganese, chromium, lead, cadmium, surface water (fresh), drinking and recreational water.

Abstract:

Samples of raw river waters and finished drinking waters have been analyzed for the past 11 years through a surveillance and monitoring program of the Federal government. Composited as well as grab samples from all over the United States were examined for nineteen trace elements using a direct-reading emission spectrograph. A study of the results from over 1500 raw and 380 finished waters shows that zinc occurred with the same frequency in both types of samples; however, the mean concentration was higher in finished water. For iron, both the frequency of detection as well as the mean value were higher in finished water. Although copper was observed with a lower frequency in finished water, the mean value was almost three times that of raw water. Manganese occurred with a greater frequency in finished water, but the mean was only one-half that of the raw water. Chromium and lead were observed at measurable levels between 15 and 18% of the time in finished waters with mean values of 7.5 and 33.9 μg/l, respectively. The corresponding figures for these elements in raw water were 24 and 19% with means of 10 and 23 μg/l. Cadmium and silver were seldom observed, either in raw or finished water.

Investigations as to the source of trace metals in finished water supplies suggest that trace elements are not generally removed from the raw water during the treatment process and that it is possible for some metals to be added to the finished water from the distribution system or by the household plumbing.

Kott, Y., N. Roze, S. Sperber, and N. Betzer.

Bacteriophages as Viral Pollution Indicators.

Water Research. 8(3):165-171. 1974.

Key Words: viruses, surface water (fresh), trickling filters, ponding/land application.

Abstract:

Ratios of coliphages to human enteric viruses in flood waters ranged from 1:1 to 10^3:1; in wastewaters in different seasons the ratio was 10^5:1; in trickling filter effluents the ratios were 10^4:1 in winter, 10^5:1 in spring, and 10^4:1 in summer and fall; in oxidation pond effluents the ratios were 10^3:1 in winter, 10^4:1 in spring, and 10^3:1 in summer and fall.

Both coliphages and enteric viruses were found in water supplies where treatment procedures had broken down.

In oxidation pond effluents coliphages were at least as resistant to chlorine as human enteric viruses.

Poliovirus 1 (LSc) and coliphage f2, introduced daily into a 350-liter experimental oxidation pond, did not decrease in numbers.

Kott, Y., H. Ben Ari, and N. Buras.

The Fate of Viruses in a Marine Environment.

Advances in Water Pollution Research. 1969:823-835.

Key Words: viruses, bacteria, surface water (marine).

Abstract:

Many techniques exist to estimate bacterial indicators found in polluted water but marine health aspects are far behind those established in water pollution.

Referring to virus detection in polluted water it is quite difficult to evaluate definite criteria as for viral number or rate of death. It is therefore evident that only few studies have been carried out on the fate of viruses in the marine environment, and it seems extremely difficult for the time being to enumerate viruses in sea water quantitatively. This study was performed using coli bacteriophages as indicators for other enteric viruses and thus enable the fate of these particles in marine environment to be followed. The serological study has proved that *E. coli* bacteriophages attack the specific bacteria, and that *Aerobacter* phages present in sea water do not cause any false positive results, and vice versa.

Various studies have emphasized that some of the enteric viruses are very stable and therefore survive long in unnatural conditions. The results of studies show that bacteriophages were affected by the natural killing properties of the sea water, but in contrast to the rapid killing of bacteria, these results were obtained after a relatively long detention period. The results obtained so far enable us to assume that coliphages are as resistant to the environment as the other enteroviruses. Thus using coliphage as a model to evaluate the fate of viruses in marine environment becomes easier.

Krauskopf, K.B.

Geochemistry of Micronutrients.

In: Micronutrients in Agriculture. R.C. Dinauer, ed. Soil Science Society of America, Madison, Wisconsin, 1972. pp. 7-40.

Key Words: iron, manganese, zinc, copper, boron, ponding/land application, land reclamation.

Abstract:

The contribution that geochemistry can make to the study of micronutrient elements in soils is far from impressive. By and large, geochemists have focused attention on aspects of the behavior of elements not closely related to soil formation, and their results are applicable to soil problems only in a disappointingly general way. The distribution in geologic materials is known to a fair degree of accuracy for the four elements Cu, Zn, Fe, and Mn, but even this basic kind of information is poorly documented for B and Mo. Much geochemical effort is devoted to working out the mechanisms by which accumulations of definite minerals of the various elements have originated, but the more indefinite forms of the elements often encountered in soils have been less attractive as a field of study. From a geochemical point of view, soils seem a particularly difficult kind of material, about which precise conclusions are impossible to draw, and which therefore should be left for some future time when we may hope to have a better fund of knowledge about simpler and more tractable substances. This is hardly a commendable attitude, as becomes glaringly apparent when one is called upon to review possible applications of geochemistry to soil problems.

Kreutner, S. and A. Lambeth.

Heavy Metal Uptake in Pasture Grass. Personal communication, May 1975.

Key Words: zinc, copper, boron, cadmium, lead, crops, livestock.

Abstract:

The authors describe the procedure and tabulate the results of an analysis of the concentration of heavy metals in pasture grain after sewage sludge had been applied for fifteen years.

Krone, R.B.

The Movement of Disease Producing Organisms through Soils.

In: Municipal Sewage Effluent for Irrigation. C.W. Wilson and F.E. Beckett, eds. Agricultural Engineering Department Symposium, Louisiana Polytechnic Institute, Ruston, Louisiana, 1968. pp. 75-195.

Key Words: viruses, bacteria, groundwater, crops, agriculture.

Abstract:

The character of disease organisms, the processes of filtration, and the experiences described above lead to the following conclusions:

1. Pathogens have a wide variety of physical and biological characteristics, including wide ranges of size, shape, surface properties, and die-away rates.

2. The processes of filtration by soil include straining at the soil surface, straining at intergrain contacts, sedimentation, and sorption by soil particles.

3. Straining of pathogens at the soil surface and sorption of viruses near the soil surface is desirable because it limits travel of pathogens most, and it is subject to wide variations in temperature and moisture, and it will assure aerobic conditions. A soil containing clay should therefore be used for irrigation with treated sewage.

4. Wide experience in irrigation with treated sewage indicates that it is safe provided that at least primary treatment is used, and provided that the crops are not consumed directly by humans. Secondary treatment and chlorination is recommended for aesthetic reasons.

The utilization of waste waters is a desirable method of conserving our water resources. Its practice has been demonstrated to be feasible, and reasonable safeguards are easily achieved. It is anticipated that as our knowledge of filtration and die-away processes increase, techniques will be developed that will make the possibility of disease transmissions even more remote.

Kruse, C.W., V.P. Oliveri, and K. Kawata.

The Enhancement of Viral Inactivation of Halogens.

In: Proceedings of the Thirteenth Water Quality Conference; Virus and Water Quality: Occurrence and Control, University of Illinois, February 1971. pp. 197-209.

Key Words: viruses, chlorination.

Abstract:

Several old concepts must be unlearned in improving viral disinfection with halogens. A major misconception is the belief that the mode of action of halogens on bacteria and virus is similar. This has led to the concept, still believed by many, that a long contact time with sufficiently high combined chlorine residuals will be virucidal. Furthermore, it is misleading to assume that the virucidal properties of ammonia haloamine are representative of combined halogens especially in regard to sewage. However, for all practical purposes, all free halogens have good virucidal properties in the pH range of natural waters.

Therefore, the halogen in water supply disinfection must be applied beyond the breakpoint to give free halogen residuals, if all the viruses are to be inactivated. For best virucidal results chlorine and bromine might be applied to water at the low pH point of treatment, such as prechlorination of coagulated surface waters. Iodine may be the virucide of choice in very alkaline water requiring disinfection such as the water in some softening works. The provision of flash mixing is of greater importance only when combined chlorine residuals are used.

In wastewater treatment, halogenation to a level of free residual is not economically feasible and the assumption that the disinfection obtained comes from the combined halogen is incorrect. Viral disinfection in sewage is accomplished in the first moments when bacteria and virus contact the uncombined free halogen. The longer the free halogen persists in uncombined form, the more complete will be the inactivation. To gain the advantage of uncombined free halogen, it is imperative to provide flash mixing, an operation seldom provided in wastewater disinfection. In addition, laboratory evidence points to a significant reduction in chlorine required, depending upon the pH of the flash mix reaction. A study of cost optimization in the field will be required to determine whether the cost of pH adjustment of the sewage with acid will be justified by the reduction in chlorine and greater virucidal efficiency.

Kubota, J., E.L. Mills, and R.T. Oglesby.

Lead, Cd, Zn, Cu, and Co in Streams and Lake Waters of Cayuga Lake Basin, New York.

Environmental Science and Technology. 8:243-248. March 1974.

Key Words: lead, cadmium, zinc, copper, cobalt, surface water (fresh).

Abstract:

Waters of 12 tributary streams of Cayuga Lake were studied to determine the levels and seasonal and geographic patterns of trace elements in the Cayuga Lake basin, a primary rural area. Trace elements in soluble form and in suspended particulates were studied. The trace element concentrations were generally low, but a seasonal pattern reflecting higher concentrations with high stream flow were noted for Pb. Values for streams of rural areas reflect levels associated with normal geochemical processes and soil weathering. An impact of urbanization was reflected in higher levels of trace elements in suspended matter in streams through urban areas.

Kudo, A. and J.S. Hart.

Uptake of Inorganic Mercury by Bed Sediments.

Journal of Environmental Quality. 3:273-278. March 1974.

Key Words: mercury, surface water (fresh).

Abstract:

The kinetics of uptake of inorganic mercury as mercuric chloride by a variety of freshwater river sediment types typical of Ottowa River sediments were studied to determine the influence of mercury concentration in water, hydrodynamic effects, sediment depth, aerobic or anaerobic conditions, and two types of water. Uptake appears to depend strongly on concentration of mercury in water and water velocity, and not on sediment depth or water type. No significant difference in uptake rates was observed between aerobic and anaerobic conditions during the 10 days studied.

Kutz, F.W., A.R. Yobs, W.G. Johnson, and G.B. Wiersma.

Mirex Residues in Human Adipose Tissue.

Environmental Entomology. 3(5):882-884. October 1974.

Key Words: epidemiology, chlorinated hydrocarbons.

Abstract:

This article reports the discovery of mirex residues in human adipose tissue in 1971-1972 from 4 males and 2 females. Mirex is an organochlorine insecticide used for control of the imported fire ant.

Labadie, J.W.

Optimization Technique for Minimization of Combined Sewer Overflow.

Colorado State University, Fort Collins, Dept. of Civil Engineering, June 1973. 89p. (Available from National Technical Information Service (NTIS) as PB-234 331).

Key Words: combined municipal and/or storm systems.

Abstract:

Methods of developing control logic for automated operation of ambient and/or auxiliary storage capabilities within combined sewer systems, with the objective of minimizing overflows to receiving waters, are analyzed and evaluated. The enormous number of control opportunities requires that the control problem be formulated as an optimization problem. The problem is defined as one of minimizing total weighted overflows, subject to an assumed hydraulic model describing flow and storage dynamics, as well as other physical constraints. The optimization problem tends to increase in complexity and degree of nonlinearity as more realistic flow models are utilized.

Labanauskas, C.K.

Manganese.

In: Diagnostic Criteria for Plants and Soils. Homer D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp. 264-285.

Key Words: manganese, ponding/land application, land reclamation, groundwater.

Abstract:

The diagnosis and control of manganese deficiency and excess in plants and soils is summarized in this chapter. The author discusses visual symptoms of and indicator plants for manganese deficiency or excess, kinds of soil in which manganese deficiency or excess most commonly occur, soil management and other practices which aggravate or reduce manganese deficiency or may produce manganese toxicity, soil analysis values of significance and methods of correcting manganese deficiency.

Lager, J.A. and W.G. Smith.

Urban Stormwater Management and Technology: an Assessment.

EPA-670/2-74-040, Metcalf and Eddy, Inc., Palo Alto, California, December 1974. 465p. (Available from National Technical Information Service (NTIS) as PB-240 687).

Key Words: BOD, suspended solids, coliforms, ammonia, nitrates, phosphates, influent characteristics, effluent characteristics, chlorination, air flotation, screening operations, other primary wastewater treatment procedures, nitrification/denitrification, adsorption/ion exchange, activated sludge, trickling filters, aerated lagoons, anaerobic lagoons.

Abstract:

Control and/or treatment of storm sewer discharges and combined sewer overflows is a major problem in the field of water quality management. A comprehensive investigation and assessment of promising, completed, and ongoing projects, respresentative of the state-of-the-art in abatement theory and technology, has been accomplished in this study. The results are presented as a compendium of project information on management and technology alternatives within a framework of problem identification, evaluation procedures, and program assessment, and selection.

Lagerwerff, J.V.

Heavy Metal Contamination of Soils.

Soil and Water Conservation Research Division, Agricultural
Research Service, United States Department of Agriculture.
Beltsville, Maryland.

Key Words: copper, cobalt, nickel, chromium, zinc, manganese, lead, ponding/land application, land reclamation.

Abstract:

The majority of the metals discussed in this presentation appear to have a number of properties in common.

1. The equilibrium between the more mobile, lower-valency forms and less mobile, higher-valency forms depends on oxidation-reduction conditions, on pH, and occasionally on microbial activity. These factors may all be interrelated.

2. To some extent, the metals occur as chelates, either by accumulating biologically in living systems or by reacting with soil organic matter.

3. To different degrees the metals are competitive with Fe. The general order of decreasing competition seems to be:

$$Cu > Co > Ni > Cr > Zn > Mn > Pb$$

The order given here is approximate, and the transposition of any two adjoining metals should be considered possible. The toxicity of these metals to plants does not necessarily follow the same order.

4. The phosphates of the metals are rather insoluble, especially under alkaline conditions.

It thus follows that unfavorable effects of heavy metals on plants generally can be alleviated by one or more of the following operations:

1. Increasing the pH of the soil to above 6.5 by liming.

2. Organic-matter treatment of soil (stubble mulching, green manuring), the pH being near or above 6.5.

3. Application of Fe, particularly as the EDTA-chelate either foliarly or to the soil.

4. Application of phosphates, provided the soil pH is managed properly.

Absolute values for the different treatments depend entirely upon the species of plants involved and ecological conditions *in topo*.

Lagerwerff, J.V. and D.L. Brower.

Exchange Adsorption or Precipitation of Lead in Soils Treated with Chlorides of Aluminum, Calcium, and Sodium.

Soil Science Proceedings. 37:11-13. January 1973.

Key Words: lead, direct contact, groundwater.

Abstract:

The exchange behavior of Pb^{2+} present in small concentrations in kaolinitic, montmorillonitic, and illitic soils pretreated with Al^{3+} or Ca^{2-}, and kept at a number of salt (Cl) levels, was in agreement with mass-action law principles. The mean values of the Gapon exchange coefficient describing the distribution of ions between the adsorbed and solution phases in Cecil, Winsum, and Yolo soils were 0.31, 0.11, and 0.24 for Pb-Al systems, and 4.13, 4.97, and 11.1 for Pb-Ca systems. In Na^+ treated, alkalized soils, Pb precipitated. The solubility of the precipitate increased with decreasing pH and concentration of salt (NaCl). The solubility in solutions used for suspending the soil was less in the presence than in the absence of soil. This may indicate that the Pb-soil complex is less soluble than the precipitate formed in solution, so that when soil is present the composition of the precipitate shifts toward a less soluble form. This would imply a multi-component nature of the precipitate.

Lambou, V. and B. Lim.

Hazards of Lead in the Environment with Particular Reference to the Aquatic Environment.

Federal Water Quality Administration, Washington, D.C., August 1970. 44p.

Key Words: lead, direct contact, fish.

Abstract:

This article discusses lead, its toxicity and effects on man, fish and wildlife and the environment, and lead consumption and industrial uses.

Lance, J.C.

Nitrogen Removal by Soil Mechanisms.

JWPCF. 44(7):1352-1361. July 1972.

Key Words: ammonia, nitrates, ponding/land application.

Abstract:

Nitrogen may be removed from a soil system in gaseous form by volatilization of ammonia or by denitrification. The amount of ammonia volatilized in a land disposal system is small, but large amounts of nitrogen could be removed during travel through a long stream or channel to the disposal area. Denitrification is perhaps the most desirable removal process because large amounts of nitrogen can be removed and transferred to the atmosphere as N_2. The nitrogen is thus completely removed from the system without causing air pollution. Additional research will be needed to determine whether denitrification can be sustained in a groundwater recharge system without prior oxidation of ammonium and/or additional sources of carbon.

The removal of plant tissue from the land is the only other means of completely removing nitrogen from the system. This is an effective method which would be unsuitable for large urban areas because it requires large areas of land. It could be attractive for small towns and cities because of availability of cheap land and the economic return from the crop harvested.

Large quantities of ammonium ion can be adsorbed by clays, but such immobilization is not permanent because it can be replaced by other cations or removed by nitrifying organisms. This mechanism can be important in concentrating most of the nitrogen into smaller volumes of water which could be treated again or used for its fertilizer value.

Large quantities of nitrogen can be immobilized by soil organic matter, but a high-rate recharge system would be saturated with nitrogen within a few years. Some nitrogen can be immobilized in microbial cells and converted to soil organic matter as the microbes die.

The natural chemical and biological processes occurring in soils offer tremendous potential for the reclamation of municipal wastewater without eutrophication hazards when a proper management system is developed and followed.

Lance, J.C., C.P. Gerba, and J.L. Melnick.

Virus Movement in Soil Columns Flooded with Secondary Sewage Effluent.

Applied and Environmental Microbiology. 32(4):520-526. October 1976.

Key Words: polio virus, viruses, groundwater, surface water (fresh), direct contact.

Abstract:

This article describes original research on the virus absorptive properties of a soil column (calcareous sand) when secondary sewage effluent is passed through. Deionized water can cause virus desorption.

Land Application of Sewage Effluents and Sludges: Select Abstracts.

EPA-660/2-74-042, Robert S. Kerr Environmental Research Laboratory, Ada, Oklahoma, Water Quality Control Board, June 1974. (Available from National Technical Information Service (NTIS) as PB-235 386).

Key Words: virus, coliforms, bacteria, ponding/land application, land reclamation, heavy metals.

Abstract:
This book is a compilation of selected abstracts on sewage and effluent application to land.

Langley, D.G.

Mercury Methylation in an Aquatic Environment.

JWPCF. 45(1):44-51. January 1973.

Key Words: mercury, surface water (fresh).

Abstract:

The results show that laboratory-controlled methylation studies are an excellent scientific tool that can be utilized successfully to monitor methylmercury accumulation in one important aquatic community. The results also indicate that mercury methylation depends on a number of parameters. These include temperature, pH, redox potential, microbial activity, mercury concentration, and organic concentration (OSI).

Methylation of existing mercury contamination in aquatic environments is a serious hazard because under certain favorable conditions methylation can occur in sediments with fairly low mercury concentrations. This study indicates that, for practical purposes, environmental mercury methylation is too slow a process to permit a natural rehabilitation through purging of contaminated sediments. It would seem that mercury-contaminated sediments would require many decades to purge themselves to natural levels. Apart from mercury removal by dredging, which has not yet been proven successful, the approach of sealing off mercury-contaminated sediments shows promise as a rehabilitation measure and warrants further investigation.

Lanouette, K.H.

Removing Heavy Metals from Waste Water.

Environmental Science and Technology. 6(6):518-522.
June 1972.

Key Words: chromium, manganese, iron, cobalt, nickel, mercury, lead, adsorption/ion exchange.

Abstract:

This is an early discussion on the removal of metals from wastewater.

Larkin, E.P., J.T. Tierney, and R. Sullivan.

Persistence of Virus on Sewage Irrigated Vegetables.

Journal of the Environmental Engineering Division, ASCE. 102 (EE1): 29-35. January 1976.

Key Words: polio virus, viruses, agriculture, ponding/land application.

Abstract:

Presently operating treating systems do not completely remove viruses from sewage sludge or effluent. Viruses have been recovered from crops irrigated or fertilized, or both, with sewage wastes. Poliovirus 1 has been shown to persist on lettuce and radishes, plants normally consumed raw, for up to 36 days.

Land disposal of sewage on soils of proper consistency results in the production of an acceptable water and helps reduce pollution of rivers and streams. Expansion of such an effective process should be encouraged where feasible. However, care should be taken to carefully evaluate land disposal from the viewpoint of groundwater pollution and contamination of food crops by pathogenic organisms. Viruses, have been shown to pass through sewage treatment plants sometimes with little or no reduction in titer or infectivity. Contamination of the food supply could result in the seeding of infection into the population, with a subsequent increase in contact infection and a resulting higher input of organisms to the sewage system. If the cycle persists, an endemic, and possibly epidemic, disease environment could develop. Municipalities contemplating sewage disposal on land should investigate the use of crops other than those in the food chain until treatment and monitoring methods are in use that would preclude the seeding of food crops with human pathogens.

Larsen, V., J.H. Axley, and G.L. Miller.

Agricultural Waste Water Accommodation and Utilization of Various Forages.

University of Maryland, College Park, Water Resources Research Center, 1974. 102p. (Available from National Technical Information Service (NTIS) as PB-234 631).

Key Words: ammonia, phosphates, groundwater, crops, effluent characteristics.

Abstract:

The influence of poultry processing plant sewage upon forages, soil, and the groundwater was studied. Harvesting the forages resulted in removal of about 200 to 300 kg N/ha/year from the system. Ammonia volatilization from plant leaves and soil after sprinkler irrigation of the sewage was 35 to 110 kg N/ha/year. It never exceeded 10% of the applied nitrogen. Denitrification within the soil accounted for 20 to 70% of the applied nitrogen. Denitrification was more important in removal of nitrogen than harvesting of the crop, when more than 970 kg N/ha/year was applied annually as sewage. Soil water dilution of the effluent acted as nitrogen sink. Two and a half ppm NO3-N was found in the groundwater at a depth of 6 m when 547 kg N/ha/year was applied. If the nitrogen application was increased to 3219 kg N/ha/year 11.2 ppm NO3-N was found in the groundwater at a depth of 9 m. This is slightly above the safe limit of 10 ppm NO3-N assigned by the U.S. Public Health Service. Ninety-five to 99% of the applied phosphorus was removed from the sewage by the first 30 cm of the soil.

Larson, T.J.

Purification of Subsurface Waters by Reverse Osmosis.

JAWWA. 75(12):1527-1848. December 1967.

Key Words: iron, manganese, reverse osmosis.

Abstract:

The conclusions to be drawn from this article are as follows:

1. Reverse osmosis is capable of purifying brackish water to produce a high-quality product at reasonable recovery ratio.

2. When operating upon waters high in bicarbonate, or at recovery ratios that produce high concentrations of bicarbonates in the feed-brine stream, a tenacious carbonate scale will tend to precipitate on the membrane to reduce product water flow and increase brine side pressure drop.

3. The formation of carbonate scale can be inhibited greatly by adjusting the pH of the feed water to a value below 6. Once formed, carbonate scale can be removed by the combined effect of acid addition to the feed to loosen and dissolve the scale, and flushing.

4. When operating on waters high in sulfate, or at recovery ratios that produce high concentrations of sulfates in the feed-brine stream, calcium sulfate will tend to precipitate on the membrane and the brine channel spacers. This will result in some reduction in product water flow but will cause a marked increase in brine side pressure drop.

5. The formation of sulfate scale within the modules can be inhibited greatly by the introduction of chemical additives, such as polyphosphates, to the feed. The use of such techniques has allowed operation at recovery ratios resulting in a concentration of a factor of four or more above saturation in the feed-brine stream without precipitation of sulfates within the modules.

6. Once formed, sulfate scale is more susceptible to removal by mechanical means, such as flushing, than carbonate scale and less susceptible to removal by chemical means, such as acid addition.

7. Precipitation of iron and manganese compounds within reverse osmosis systems can be inhibited greatly by reduc-

ing the pH of the feed to a value less than 6 and employing relatively straightforward measures to minimize aeration of the feed.

8. Additional work is necessary to study the long-term economics of reverse osmosis systems on brackish water.

Lau, L.S.

Water Recycling of Sewage Effluent by Irrigation: A Field Study on Oahu.

University of Hawaii, Honolulu, Water Resources Research Center, 1974. 110p.

Key Words: ammonia, BOD, COD, chlorides, cyanides, nitrates, nitrites, oil and grease, phosphates, suspended solids, total dissolved solids, boron, coliforms, adeno virus, coxsackie virus, ECHO virus, viruses, cadmium, lead, mercury, DDT, surface water (fresh), DDD, chlorinated hydrocarbons.

Abstract:

The primary objective of the project is to determine the feasibility of wastewater application to the soil and its probable effects on the quantity of groundwater in terms of dissolved materials and viruses.

Law, J.P., Jr., R.E. Thomas, and L.H. Myers.

Cannery Wastewater Treatment by High Rate Spray on Grassland.

JWPCF. 42(9): 1621-1631. September 1970.

Key Words: BOD, COD, ponding/land application.

Abstract:

A 12-month study was conducted to determine the treatment efficiency of a spray-runoff treatment system for cannery wastes. A total of 133 in (338 cm) of wastewater was applied to each of four experimental areas. Hydrological measurements, mass removal efficiencies, and soil water quality were evaluated in relation to age of system, soil type, and spray scheduling.

Hydrological measurements showed that 18 percent of the applied water was lost through evaporative processes; 61 percent returned to surface streams as runoff; and the remaining 21 percent percolated through the soil.

The quality of the wastewater varied regularly according to routine changes in cannery processing operations. The soil system provided a buffering capacity which eliminated most of this variability from the quality of the stream leaving the farm.

The normal once-a-day spray schedule resulted in 92 to 99 percent removal of the volatile solids and oxygen-demanding organics, 83 to 90 percent removal of total nitrogen, and 50 to 63 percent removal of total phosphorus. System age had no consistent effect on treatment efficiency, while the sandy loam soil showed a slight advantage over the loam to clay loam soil.

Changing the spray schedule from once a day to three times a week improved the phosphorus removal on one of the experimental areas from about 50 percent to 88 percent. Spreading the organic load over more land area had little effect on treatment efficiency.

Data from three farm effluent stations verified the ability of the spray-runoff treatment system to produce a highly treated effluent throughout the year. Soil water showed a marked increase in total dissolved salts in the older areas, but nitrogen and phosphorus remained low. The soil water should be monitored again in a few years to determine if the conditions under the older area are approaching a stable state. Similar attention should be given to the sodium buildup in the soil water to determine if stable conditions occur before the problem becomes serious.

Simple concentration reduction does not give a true picture of the treatment efficiency of the system. Treatment efficiencies were computed on a mass removal basis for a better evaluation of the system. Five key parameters were selected for this evaluation and the data are summarized in this report. The values are quarterly means for each of the four experimental areas along with the 6-month means.

The effects of soil type and system age were evaluated during the first 6 months of the study. Although the differences were not great, examination of the data for each of the study areas indicated that experimental lines G-4 and G-11, which were on the sandy loam soil, had greater treatment efficiencies than their respective counterparts, Y-1 and B-11, on the loam to clay loam soil. Mass removals for BOD, COD, and VSS were consistently high for all areas. The effects due to age were not as consistent. A comparison of 5-yr-old line G-4 with 3-yr-old line G-11 showed the effect of age on the sandy loam soil. A similar comparison of 5-yr-old line Y-1 with 3-yr-old line B-11 showed the effect of age on the heavier soils. There was a tendency for the older lines to show better removals, but the effect was not consistent for any of the five parameters. The results of this comparison showed no consistent effect due to age. Nitrogen and phosphorus removals were not as high as were BOD, COD, and VSS removals, but were still better than the concentrations that conventional treatment methods normally achieve. Phosphorus removals were substantially less than those of the other four constituents.

Law, L.M. and D.F. Goerlitz.

Selected Chlorinated Hydrocarbons in Bottom Material from Streams Tributary to San Francisco Bay.

Pesticides Monitoring Journal. 8:33-36. June 1974.

Key Words: DDT, DDE, DDD, chlorinated hydrocarbons, surface water (fresh).

Abstract:

As part of a study of the environmental quality of San Francisco Bay, bottom material from 26 streams tributary to the Bay were analyzed for chlordane, DDD, DDE, DDT, and PCB residues. These compounds were present in essentially all streams tested. Chlordane proved to be ubiquitous, with a concentration range similar to that of the other compounds. Noteworthy was the occurrence in one stream of polychlorinated naphthalene residues. Compounds occurring in concentrations above 20 μg/kg were identified in most instances by combined gas chromatography/mass spectrometry.

Lawrence, A.W.

Kinetics of Microbiologically Mediated Transformations of Heavy Metals in Aquatic Environments.

Cornell University, Ithaca, New York, Dept. of Environmental Engineering, June 1974. 21p. (Available from National Technical Information Service (NTIS) as PB-239 148).

Key Words: mercury, surface water (fresh), surface water (marine), chemical treatment, adsorption/ion exchange.

Abstract:

This is a discussion of methylation of mercury and a review of metals removal.

Lawrence, A.W. and P.L. McCarty.

The Role of Sulfides in Preventing Heavy Metal Toxicity in Anaerobic Treatment.

JWPCF. 37(3):392-406. March 1965.

Key Words: copper, iron, nickel, zinc, anaerobic lagoons.

Abstract:

The following conclusions can be drawn from this study:

1. Soluble copper, zinc, and nickel heavy-metal salts are toxic to anaerobic treatment.

2. Exceptionally high concentrations of iron can be tolerated in anaerobic treatment, if the iron is added daily along with the feed.

3. Under anaerobic treatment, toxic heavy metals can be precipitated and rendered non toxic in the presence of an equivalent concentration of sulfides.

4. The total concentration of toxic heavy metals which can be tolerated is related directly to the quantity of sulfides present for their precipitation.

5. The addition of sulfide or sulfide precursors has allowed the presence of more than 10 percent of heavy metals on a dried volatile solids basis without inhibiting the digestion process.

6. The addition of sulfides or sulfide precursors to relieve heavy-metal toxicity is a sound control procedure.

Lawrence, J. and H.M. Tosine.

Adsorption of Polychlorinated Biphenyls from Aqueous Solutions and Sewage.

Environmental Science and Technology. 10(4):381-383.
April 1976.

Key Words: synthetics, chlorinated hydrocarbons, pesticides, adsorption/ion exchange.

Abstract:

The purpose of this work was to study the feasibility of extracting PCB's from raw sewage by adsorption onto various media. However, because of the varying nature of raw sewage, the adsorption was first studied using synthetic aqueous solutions of Aroclor 1254 and 1242.

The adsorption of PCB's from synthetic aqueous solutions and raw sewage has been studied on a variety of adsorbents, including activated carbons, polymeric resins, polyvinyl chloride, and polyurethane foams. The carbons, foams, and XAD-2 strongly adsorbed the PCB's from aqueous solutions but were much less effective in raw sewage. The PVC, however, was very effective in raw sewage. A small-scale treatment unit was designed to demonstrate the feasibility of removing PCB's from sewage by this method.

Leary, R.D., L.A. Ernest, R.S. Powell, and R.M. Mathe.

Two-hundred MGD Activated Sludge Plant Removes Phosphorus by Pickle Liquor.

EPA-670/2-73-050, Milwaukee Sewerage Commission, Wisconsin, September 1973. 137p. (Available from National Technical Information Service (NTIS) as PB-228 561).

Key Words: phosphates, iron, activated sludge, effluent characteristics, chemical treatment.

Abstract:

1. Waste pickle liquor (ferrous sulfate) as an iron source has been continuously and successfully added to precipitate phosphorus since January 1970 in the 115 MGD East Plant at the Milwaukee Sewerage Commission's Jones Island Activated Sludge Waste Water Treatment Plant. The 85 MGD West Plant receiving the same raw screened sewage was operated as a control for the first 15 months after which time, East Plant waste sludge was added to the West Plant return sludge as an iron source.

2. Based on an average 1971 screened sewage total phosphorus concentration of 7.1 mg/l P, the East Plant with iron addition, removed 90.3% (0.69 mg/l P effluent residual) while the West Plant removed 81.7% (1.3 mg/l P effluent residual). After the mixing of the East Plant waste sludge in the West Plant, the total phosphorus removal from May 1971 to April 1972 in the East and West Plants averaged 90.4 and 79.5% (0.70 and 1.5 mg/l P effluent residual) respectively. During certain months, the total phosphorus concentration was high because mixed liquor suspended solids were discharged into the effluent, therefore, the total soluble phosphorus concentrations are a better indication of the effectiveness of the iron addition.

3. Based on an average 1971 screened sewage total soluble phosphorus concentration of 2.3 mg/l P, the East Plant effluent had a residual concentration of 0.22 mg/l P, while the West Plant effluent concentration averaged 0.58 mg/l P. During the May 1971 to April 1972 period when the East Plant waste sludge was added to the West Plant return sludge, the total soluble phosphorus values for the East and West Plant effluents averaged 0.22 and 0.64 mg/l P.

4. An average of 8.0 mg/l iron was added to the East Plant mixed liquor (11,546 gallons/day at 0.74 pounds/gallon) to remove phosphorus. No minimum iron dose testing was conducted, but obviously, the 1971 minimum was below 8.0 mg/l iron at the Jones Island East Plant.

5. The pickle liquor addition increased the return sludge phosphorus concentration in 1970 from 2.29% as P in the control West Plant to 2.61% as P in the East Plant, and also increased the iron content from 1.86% as Fe in the West Plant to 5.08% as Fe in the East Plant.

6. The addition of iron to the East Plant mixed liquor increased the effluent iron concentration slightly. During the 1970 demonstration period, the West and East Plant effluent total iron concentration ions averaged 0.51 to 1.2 mg/l Fe and the total soluble iron concentrations averaged 0.21 and 0.24 mg/l Fe, respectively. The difference in total iron concentrations was attributed to the increased concentration of iron in the East Plant suspended solids. In 1971, soluble iron concentrations averaged 0.18 and 0.13 mg/l Fe, respectively, in the West and East Plant effluents.

7. Comparison of the efficiencies of the West and East Plant in removing BOD, COD, and suspended solids as well as microscopic examination of the mixed liquors indicated that the addition of unneutralized pickle liquor apparently did not affect purification.

The major objective of the iron addition was to maintain an East Plant effluent total phosphorus concentration of 0.50 mg/l P and obtain a total plant phosphorus removal of 85% as required by the Wisconsin Department of Natural Resources by December 1972. The West and East Plant effluent total phosphorus concentrations during 1971 averaged 1.3 and 0.69 mg/l P respectively, representing an average overall 86.6% removal. The effluent total soluble phosphorus concentrations for the West and East Plants averaged 0.58 and 0.22 mg/l P.

Leary, R.D., L.A. Ernest, G.R. Douglas, A. Geinopolos, and D.G. Mason.

Top-Feed Vacuum Filtration of Activated Sludge.

JWPCF. 46(7):1761-1768. July 1974.

Key Words: vacuum filters.

Abstract:

The following conclusions can be drawn from the data presented in this report:

1. A side-by-side comparison demonstrated that higher filter yields at improved filter cake solids were obtained on the top-feed filter as compared with bottom-feed filters operating under nearly the same conditions.

2. Cake discharge from the top-feed filter is excellent and requires no blow-off. This maximizes cake solids by eliminating filtrate blowback and minimixes blinding by cutting down in sludge cake and scraper contact.

3. More work is required on hopper seal design.

Ledbetter, J.O.

Air Pollution from Aerobic Waste Treatment.

Water and Sewage Works. 111(1):62-63. January 1964.

Key Words: bacteria, air.

Abstract:
Aerosols are air suspensions of particulates usually less than 50 microns (approximately 1/500th in) in size. Aerosols are given off by all types of aerobic waste treatment. These particulates emerge as mists or droplets that come out of the main body of liquid waste being treated by emerging bubbles or by mechanical spattering. Under most atmospheric conditions, the droplets quickly evaporate, leaving the nuclei of solid wastes that were dissolved or suspended in the droplet. At best the nuclei are dusts that are added to the burden of pollutants in the air, but they may contain material that is hazardous to the health. It has been documented by competent people in the field that bacteria are often transported by aerosols from liquids, that pathogenic bacteria survive the waste treatment processes, and that other irritating materials may be carried in this manner. That the risk of infection or disease caused or transmitted in this manner is small, is readily admitted.

Ledbetter, J.O. and C.W. Randall.

Bacterial Emissions from Activated Sludge Units.

Industrial Medicine and Surgery. 34:130-133. February 1965.

Key Words: coliforms, groundwater.

Abstract:

The airborne bacterial counts made on 35 different days exhibit conclusive evidence that the bacterial population of air is increased by passage over an activated sludge waste treatment unit.

Despite a rapid die-off of bacteria, an increase in the bacterial population persists for a considerable distance and time. The distance is strongly dependent upon wind velocity.

No effects of relative humidity and temperature could be noted in this study.

The investigation is continuing with future plans to identify serotypes in an effort to evaluate the health hazard involved.

Ledbetter, J.O., L.M. Hauck, and R. Reynolds.

Health Hazards from Wastewater Treatment Practices.

Environmental Letters. 4(3):225-232. 1973.

Key Words: epidemiology, activated sludge, air.

Abstract:

The added hazards for respiratory disease from working at a wastewater treatment plant are quite small; tentatively, it may be said that they are insignificant. There is a logical and theoretical increase in the probability of pneumonia but the firm data which we have do not indicate that any increase occurs. There are considerably more colds among employees of wastewater treatment plants than among those of water treatment plants. Also, the incidence of flu is higher in the same order.

Efforts will continue to categorize the doubtful cases of all three diseases. When the data are firmed up, statistical significance tests will be applied to the differences. A survey of much larger populations will be attempted in order to define more narrowly the probable risk associated with the wastewater treatment practice of bubbling air through microbial cultures in the wastewaters.

Ledet, E.J. and J.L. Laseter.

Alkanes at the Air-Sea Interface from Offshore Louisiana and Florida.

Science. 186:261-262. October 1974.

Key Words: synthetic/organics, surface water (marine).

Abstract:

Alkanes at the air-sea interface were analyzed in 118 surface samples collected at five different intervals over a 12-month period. Unexpectedly, methyl branched alkanes ranging in chain length from C_{15} to C_{35} and cycloalkanes were frequently the predominant components. This suggested that the alkanes are produced by natural biological sources as well as human activities.

Lee, D.H.K.

Nitrates, Nitrites, and Methemoglobinemia.

Environmental Research. 3:484-511. 1970.

Key Words: nitrates, nitrites, drinking and recreational water.

Abstract:

This is an excellent review article on the clinical picture, toxicology, and ecology of nitrates and nitrites in food and drinking water.

Lee, G.F. and G.D. Veith.

Water Chemistry of Toxaphene - Role of Lake Sediments.

Environmental Science and Technology. 5:230-239. March 1971.

Key Words: synthetic/organics, surface water (fresh), surface water (marine).

Abstract:

The role of lake sediments in the detoxification of lakes which were treated with toxaphene was evaluated under environmental and laboratory conditions. The extent of toxaphene accumulation in sediments of three Wisconsin lakes was determined by electron capture gas chromatographic analysis of core sections and Ekman dredge samples. The toxaphene concentration in the 0 to 5-cm level of the sediment increased for 190 days following the treatment of the lakes and then began decreasing by a factor of 2 every 120 days. Toxaphene was transported vertically to the 5 to 10-cm and the 10 to 15-cm level of the sediment at rates varying from 0.4 to 1.1 cm per day in the three lakes. Toxaphene was not detected below the 20-cm level of the sediments. Toxaphene which was sorbed onto the sediment in the lake could not be leached from the sediment by lake water under laboratory conditions.

Toxaphene accumulated to concentrations as great as 90.0 μg/g (dry weight) and the transport to the sediments was attributed to direct sorption onto the sediment and to co-deposition with toxaphene-ladened algal blooms and other particulate matter. Toxaphene concentrations in the sediment decreased from observed maxima by a factor of 2 every four months in the three Wisconsin lakes. Toxaphene was transported vertically in the sediments at rates of 0.4 to 1.1 cm per day to the 10 to 15-cm level and was attributed to physical mixing of the sediments. Laboratory studies demonstrated that the sorption of toxaphene on sediment was irreversible in aqueous solution and that leaching of appreciable amounts of toxaphene by water is highly improbable.

Lee, J.A., C.S. Shih, and J.A. De Filippi.

Filtering Combined Sewer Overflows.

JWPCF. 44(7):1317-1333. July 1972.

Key Words: suspended solids, BOD, COD, filtration, combined municipal and/or storm systems.

Abstract:
The laboratory studies confirm that ultra-high-rate filtration is a technically feasible process for the removal of ss and associated nonsoluble BOD from combined wastewater. Of the three filter systems tested, the fiber glass filter performed the best by achieving at least 90 percent removal of ss and 70 percent removal of non-soluble BOD_5. These results were achieved at filtration rates ranging from 15 to 30 gpm/sq ft (610.5 to 1,221 l/min/sq m) and with filter runs of 1- to 3-hr duration. Comparable effluent quality was not obtained in the trimedia filter runs at rates in excess of 10 gpm/sq ft (407 l/min/sq m). Up-flow filtration through a garnet bed was unsatisfactory because of very poor effluent quality. Soluble BOD removal was negligible in all three filter systems even with the addition of activated sludge to the influent wastewater. However, low dosages of about 50 mg/l of activated sludge were imposed by the limitations of the apparatus; greater dosages might have been effective. The nonsoluble organic content of the influent wastewater seemed to have a greater impact on head loss than did the inorganic ss content.

From the results of these observations, it can be concluded that an improved effluent quality (lower concentrations of ss, BOD_5 and COD) could be obtained from the fiber glass filter by (a) increasing total bed depth, (b) increasing media density in the bottom layer, or (c) optimizing density gradation.

A multi- or graded-density fiber glass bed is needed to retain large solids and to permit the passage of smaller solids through shallow media depths to make the most efficient use of pore space and avoid premature clogging at the shallower depths of the bed. Turbidity of effluent from the fiber glass filter was caused by very fine particulates, and it is believed that a bottom density in excess of 15 lb/cu ft (240 kg/cu m) could reduce effluent concentrations of ss to less than 40 mg/l.

Pretreatment would be required in a full-scale application of the process under study. Large suspended and floatable solid particles could be removed from the wastewater by a

grit chamber and a series of coarse screens. The wastewater collection and storage facility could be designed to function as a grit removal chamber. Field sampling experience acquired during this study indicates screening through 1-in (2.54-cm) mesh effectively removes large particles which might interfere with efficient filter operation.

Meaningful cost estimates for a full-scale filtration plant utilizing the fiber glass medium are not obtainable without further study of the FRP cartridge service life.

The economic feasibility of ultra-high-rate filtration may depend on extending the useful life of the fiber glass medium beyond the limits indicated by the laboratory tests. Improvement of the backwash operation through modification of underdrain design, staged removal of backwash effluent, the use of air scouring during backwash, and development of improved fiber glass bed designs and fiber glass media regeneration techniques seem to be promising approaches to the extension of filter life.

Lee, J.H., C.E. Nash, and J.R. Sylvester.

Effects of Mirex and Methoxychlor on Striped Mullet, Mugil cephalus L.

EPA-660/3-75-015, Oceanic Institute, Waimanalo, Hawaii, May 1975. 26p. (Available from National Technical Information Service (NTIS) as PB-241 635).

Key Words: chlorinated hydrocarbons, surface water (fresh), fish.

Abstract:

The following conclusions were made:

1. Young juvenile mullet (20-43 mm standard length) were apparently more susceptible to mirex exposure than older juveniles (70-150 mm standard length) or adults (260-380 mm standard length).

2. Mirex was accumulated by mullet, and body concentrations in whole fish (wet weight) increased with increased concentration in test water, which indicates that the insecticide is stable in striped mullet.

3. Mirex was accumulated most (21.5 μg/g) in visceral organs and least (1.4 μg/g) in skin and muscle of adult mullet for a 96-hour exposure period. Gills and hearts accumulated 2.0 μg/g for the same exposure time.

4. Methoxychlor was more toxic to mullet than mirex at concentrations of 0.1, 1.0 and 10.1 mg/l over a 96-hour period. However, mortalities of young juveniles in 0.1- and 1.0-mg/l mirex-treated water were 27 and 32 percent respectively, by far the highest among mirex-exposed fish or controls. No mortality occurred among older juveniles and adults exposed to mirex over the same experimental period.

5. Relative to mirex, small amounts of methoxychlor were accumulated in whole juvenile and adult mullet. Test fish exposed to 10.0 mg/l methoxychlor contained 1.7 μg/g for juveniles and 11.1 μg/g for adults over a 96-hour period.

6. Results with eggs and larvae were inconclusive because of the natural high mortality of both stages in culture conditions. Eggs and larvae from the same broodstock had a better survival rate in mirex than in methoxychlor.

Lee, R.D., J.M. Symons, and G.G. Robeck.

Watershed Human Use Level and Water Quality.

JAWWA. 62(7):412-422. July 1970.

Key Words: coliforms, fecal streptococci, viruses, bacteria, direct contact, groundwater, surface water (fresh), drinking and recreational water,

Abstract:

Conclusions based on the results of this study are as follows:

1. By present techniques, no measurable influence could be determined on bacterial indicator population densities because of the increase in human use level among the Cedar River, the Green River, and the Clackamas River watersheds.

2. The animal population on all three watersheds was much higher than the human use level and generally similar among watersheds.

3. Enteric pathogens were recovered with a special flow-through sampler from the most downstream station on all three watersheds.

4. Fecal coliforms, fecal streptococci, and enteric pathogens were recovered from some of the remote sampling stations with low human use levels.

5. Viruses were not isolated by culturing methods used on the samples taken with the flowthrough sample.

6. The turbidity of the water flowing from these three watersheds as measured by grab samples was generally low.

7. Peak turbidities occurred during times of high streamflow, but the indicator organism densities were low at this time.

8. The chemical quality of the water flowing from all three watersheds was good and was similar among the watersheds, showing that the level of human use existing during this study had no measurable effect on chemical water quality by present techniques.

Lefler, E. and Y. Kott.

Virus Retention and Survival in Sand.

In: Virus Survival in Water and Wastewater Systems. J.F. Malina, Jr. and B.P. Sagik, eds. University of Texas at Austin, Center for Research in Water Resources, 1974. pp. 84-91.

Key Words: polio virus, virus, ponding/land application, land reclamation.

Abstract:

In any wastewater reclamation project in which percolation of treated effluents through sand will be used, all the known and foreseen parameters should be investigated beforehand. The extent of treatment, and precautions required prior to sand infiltration depends very much on the efficiency of the sand in retaining the viruses on one hand, and viral survival under such conditions on the other.

The current study was aimed to investigate the retention capacity of the sand and follow the die-away of the viruses under these conditions. The results that were recorded showed that viral particles behave very closely from chemical-physical point of view to what is known in literature on bacterial sorption to sand.

A method which simplified test procedures was to withdraw sand samples from the experimental columns and to inoculate them directly to tissue culture bottles. This method increased the viability of results achieved. The use of the Most Probable Number (MPN) in evaluation concentration of f_2 bacteriophage enabled counts to be performed as low as less than two particles in one hundred ml volume. The various experiments have demonstrated that when viruses were suspended in distilled water, very poor retention was achieved. If these theoretical results are compared to those achieved under field conditions, it should be analogically considered to rain conditions. In many countries such rains come in wintertime when temperatures are fairly low, causing a double effect: a deeper penetration of the viruses in the sand, and longer survivals. This was found when the viruses were kept in 4 to 8^0 C.

LeGendre, G.R. and D.D. Runnells.

Removal of Dissolved Molybdenum from Wastewaters by Precipitates of Iron.

Environmental Science and Technology. 9:744-749. August 1975.

Key Words: molybdenum, chemical treatment.

Abstract:

Molybdenum is an important industrial element. It is also an essential metallic cofactor in several enzymes. At high concentrations in forage it can be toxic to ruminant animals. High concentrations of Mo are in the aqeuous, solid, and airborne effluents from many industrial operations. In the laboratory it can be removed from aqueous effluent by adsorption or coprecipitation with solid ferric oxyhydroxide at low pH. A field example is given, taking place today in a stream in Colorado that receives dissolved molybdenum from a mining and milling operation. The precipitate in the stream is a mixture of iron compounds, including natrojarosite, $NaFe_3(SO_4)_2(OH)_6$, goethite, $FeO(OH)$, and amorphous material enriched in molybdenum.

From this study we conclude that removal of dissolved molybdenum by precipitates of ferric iron is an effective process in the laboratory and in at least one field situation. Under the proper conditions of low pH and high iron content, it appears that essentially all dissolved molybdenum can be removed.

In the stream waters which we studied, with the exception of one sample, the molybdenum was not removed by filtration through a 0.01μ filter. We conclude that molybdenum in natural waters is essentially all dissolved and that only under extraordinary conditions of low pH and high iron can simple filtration be used for removal. However, at least some molybdenum-rich waters can be effectively purified by removal of precipitated ferric compounds at low pH. This promising procedure is now being bench tested by two engineers as a possible economic method to purify certain industrial effluents and to recover the molybdenum values.

Lejcher, T.R. and S.H. Kunkle.

Restoration of Acid Spoil Banks with Treated Sewage Sludge.

In: Conference on Recycling Treated Municipal Wastewater through Forest and Cropland. W.E. Sopper and L.T. Kardos, eds. EPA-660/2-74-003, Pennsylvania State University, University Park, Institute for Research on Land and Water Resources, March 1974. pp. 165-178.

Key Words: aluminum, iron, cadmium, chromium, zinc, manganese, ammonia, nitrates, coliforms, copper, lead, thorium, land reclamation.

Abstract:

This report details the preliminary results of a strip mined reclamation demonstration project in southern Illinois. The initial observations indicate that treated municipal sludge, when applied to the spoil in sufficient amounts, improves spoil pH, allows establishment of vegetation and reduces acidity and concentrations of some of the chemicals in the runoff issuing from the tract.

The proposed application of sludge to a larger 77 hectare area should provide some insight into the practicality of sludge treatment on strip mined areas. If such treatment is practical, three main advantages could possibly result: (1) reclamation of useless stripped areas, (2) reduction of water pollution associated with these areas, and (3) the disposal of municipal sludge.

Leland, H.V., W.N. Bruce, and N.F. Shimp.

Chlorinated Hydrocarbon Insecticides in Sediments of Southern Lake Michigan.

Environmental Science and Technology. 7(9):833-838. September 1973.

Key Words: chlorinated hydrocarbons, surface water (fresh).

Abstract:

Past usage of organochlorine insecticides in states bordering southern Lake Michigan has resulted in the presence in the lake sediments of large reservoirs of DDT, DDE, DDD, and dieldrin. Analysis of surficial sediments from different areas of southern Lake Michigan indicated high positive statistical correlations between t-DDT (DDT, DDE, DDD) and dieldrin concentrations in the sample and organic carbon content. The amount of organic carbon in surficial sediments was directly proportional to the clay-size fraction of sediment. Dechlorination of DDT to form DDD apparently predominates under the reducing conditions of sediments on the eastern side of the south basin of Lake Michigan. In other areas, DDT is the principal component of the t-DDT complex in sediments and DDE and DDD are major degradative products.

Leland, H.V., S.S. Shukla, and N.F. Shimp.

Factors Affecting Distribution of Lead and Other Trace Elements in Sediments of Southern Lake Michigan.

In: Trace Metals and Metal-Organic Interactions in Natural Waters. P.C. Singer, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1974. pp. 89-129.

Key Words: arsenic, chromium, copper, mercury, lead, zinc, surface water (fresh), fish.

Abstract:

Surface enrichment of arsenic, bromine, chromium, copper, mercury, lead and zinc, attributable in part to man's activities, exists in modern surficial sediments of southern Lake Michigan. These trace elements are apparently sorbed, either directly or through biological processes, to suspended particles, which are transported by water and deposited eventually in geographic areas of active sedimentation. The relative influences of specific sediment components on sorption and retention of the above elements are unknown, but regression analysis indicates a relationship between trace element content and amounts of organic matter and iron oxide in the sediments. Recent literature on heavy metal transport emphasizes the importance of metal interactions with organic matter and hydrous oxides of iron and manganese.

Lemke, H.S. and A.T. Sinskey.

Viruses and Ionizing Radiation in Respect to Wastewater Treatment.

Contribution No. 2630 of the Department of Nutrition and Food Science, Massachusetts Institute of Technology, Cambridge.

Key Words: viruses, radiation treatment.

Abstract:

After a short survey of viruses and the diseases they can cause in man the effects of ionizing radiation on viruses are discussed. Ionizing radiation inactivates viruses by direct and indirect effects, and it is well established that the radiosensitive target is the nucleic acid. Factors affecting the radiosensitivity are temperature and suspending menstruum. The possible influence of oxygen on viral radiosensitization remains unclear. For the effective application of radiation treatment on waste waters information is required concerning the concentration of viruses in waste waters in order that treatment doses may be determined.

Leong, L., B. Olson, and R. Cooper.

Methylmercury and Environmental Health.

Journal of Environmental Health. 35(5):436-441. March/April 1973.

Key Words: mercury, surface water (fresh), surface water (marine).

Abstract:

This is a good general (slightly technical) review of methylated form of mercury; it discusses microbial transformation and bioaccumulation.

Leptospirosis Annual Summary 1975.

U.S. Center for Disease Control, HEW. July 1976.

Key Words: epidemiology, surface water (fresh).

Abstract:

This article discusses 119 cases of human leptospirosis with onset in 1975, and the most common probable sources of infection were surface water and dogs.

Lerman, A. and C.W. Childs.

Metal-Organic Complexes in Natural Waters: Control of Distribution by Thermodynamic, Kinetic and Physical Factors.

In: Trace Metals and Metal-Organic Interactions in Natural Waters. P.C. Singer, ed. Ann Arbor Science Publishers, Ann Arbor, Michigan, 1974. pp. 201-235.

Key Words: copper, lead, iron, nickel, cobalt, zinc, surface water (fresh), surface water (marine).

Abstract:

Two organic compounds, nitrilotriacetate (NTA) and citrate, which may conceivably appear in natural waters affected by industrial societies, have a potential to modify the existing distributions of ionic species in waters. The two compounds form strong complexes with such metal-ions as Cu, Pb, Fe, Ni, Co, and Zn, and somewhat weaker complexes with such major constituents of natural waters as Ca and Mg.

A study of thermodynamic equilibria in a model fresh water (similar in composition to an average river and lake water) shows that NTA and citrate complex virtually all available Cu, Fe, Pb, Ni, Co, and Zn. When no more of these metal-ions are available for complexation but the ligand concentration continues to rise owing to input from outside, then NTA and citrate form complexes with Ca and, to a lesser extent, Mg. In fresh waters, such concentrations of NTA or citrate can significantly affect the concentration of Ca in ionic form, and they may therefore be potentially damaging to many fresh water environments.

Leshniowsky, W.O., P.R. Dugan, R.M. Pfister, J.I. Frea, and C.I. Randles.

Aldrin: Removal from Lake Water by Flocculent Bacteria.

Science. 169(3949):993-995. September 4, 1970.

Key Words: aldrin, surface water (fresh).

Abstract:
Floc-forming bacteria isolated from Lake Erie adsorb and concentrate aldrin from colloidal dispersion so that the settling of the bacterial flocs removes aldrin from the water phase. Contemporary sediments forming in Lake Erie contain aldrin and could adsorb more. The sediments consist of a conglomerate floc of bacteria, diatoms, and inorganic and detrital particles. Flocculent bacteria also adsorb microparticulates, and this adsorption capacity represents a mechanism for sediment formation and for the removal of suspended particles including aldrin from the water column.

Leven, G.V. and J. Shapiro.

Metabolic Uptake of Phosphorus by Wastewater Organisms.

JWPCF. 37(6):800-818. June 1965.

Key Words: phosphates, BOD, surface water (fresh), aerated lagoons.

Abstract:

The research reported in this paper was directed toward the removal of phosphorus from effluents and thus from natural bodies of water. The specific aim was to modify aeration wastewater treatment processes to produce effluents low in phosphorus.

Leven, G.V., G.J. Topol, A.G. Tarnay, and R.B. Samworth.

Pilot-Plant Tests of a Phosphate Removal Process.

JWPCF. 44(10):1940-1954. October 1972.

Key Words: phosphates, activated sludge.

Abstract:

Analysis of the data and review of the operating experience presented permit the following conclusions:

1. The new process removed approximately 90 percent of the total phosphorus present in domestic wastewater and produced an effluent containing 0.69 mg/l total P. Orthophosphate was reduced to 0.07 mg/l as P.

2. The addition of a filtration step may increase total phosphorus removal to approximately 95 percent, producing an effluent containing 0.28 mg/l total P.

3. The method is compatible with the conventional activated sludge process and appears to be compatible with modifications of it.

4. The process produces less chemical sludge than phosphorus removal processes treating the entire wastewater flow.

5. Tendencies to reduce bulking, improve settling, and improve shock resilience are indicated for the process.

6. The method provides a sludge reservoir to control MLSS.

7. Principally, through drastic reductions in chemical dosage, the method promises to offer a high degree of phosphorus removal considerably cheaper than other available methods.

8. Sufficient data have now been obtained in the field and the laboratory to warrant full-scale application of the biological process for phosphorus removal.

Levin, M.A. and V.J. Cabelli.

Membrane Filter Technique for Enumeration of *Pseudomonas aeruginosa*.

Applied Microbiology. 24(6):864-870. December 1972.

Key Words: bacteria, surface water (fresh), drinking and recreational water.

Abstract:

This article is mainly methodology, but has some data on numbers of pseudomona in water and sewage samples.

Lewin, R.

Cancer Hazards in the Environment.

New Scientist. 69(984):168-170. January 22, 1976.

Key Word: epidemiology.

Abstract:

There is an increasing demand for a reliable test for detecting cancer-causing substances in the environment to enable us to avoid future catastrophe. This article discusses this situation.

Liao, P.B. and M.J. Pilat.

Air Pollutant Emissions from Fluidized Bed Sewage Sludge Incinerators.

Water and Sewage Works. 119(2):68-74. February 1972.

Key Words: nitrates, synthetic/organics, total organic carbon, incineration.

Abstract:

The amounts of gaseous pollutants (except water vapor) emitted from a fluid bed sewage sludge incinerator are quite small: 2.79 lb SO_2, 0.022 lb CO, and 1.14 lb NO_4 per ton dry sewage sludge burned. Thus, with the present emission standards, controls for these pollutants are not required.

Field test results indicate that more than 95 percent of the exhaust solids has particle sizes greater than 30 microns and that particle density is about 1.5 grams/cm^3. Under normal operating conditions the suspended particulates emitted are of 1 grain or less per standard cubic foot mass concentration and of size distribution with a mean diameter of 123 microns with a geometric standard deviation of 2.82. The uncontrolled particulate emission rate is about 94.5 lb particulate per ton dry sludge burned. Therefore, control of particulate matter emissions is necessary. However, test results indicate that a water scrubber or equivalent is adequate for particulate removal. All the pollutant concentrations in samples collected downstream of the control facility-water scrubber met the local air pollution control codes which are $SO_2 \leq 2,000$ mg/l and particulate mass concentration $\leq .02$ grain/scf (0.10 grain/scf for new installation).

Water vapor emitted from a fluidized bed sewage sludge reactor may be objectionable, although the State of Washington currently does not consider it as a pollutant and requires no control. Sewage sludges injected into the reactor contain more than 65 percent of water by weight resulting in a white plume from the exhaust stack. When the local meteorological conditions are not favorable for plume dispersion and the relative humidity is high - water vapor plume may sweep residential or business areas near the plant. Complaints against the plume have been received by the cities operating this type of incinerator. Should water vapor control become necessary a demister in the exhaust pipe will remove water from the gas stream. If dilution is acceptable as a pollution control method, a taller stack could be installed. Another method involves condensing the water vapor from the gas stream.

The amounts of SO_2 and water vapor emitted from a fluidized bed sewage sludge incinerator increase slightly with an increase in the sludge loading rates.

Lieb, A.J., D.B. Bills, and R.O. Sinnhuber.

Accumulation of Dietary Polychlorinated Biphenyls (Aroclor 1254) by Rainbow Trout (Salmo gairdneri).

Journal of Agricultural and Food Chemistry. 22(4):638-642. July/August 1974.

Key Words: chlorinated hydrocarbons, fish.

Abstract:

The accumulation of PCB's (Aroclor 1254) by a Mt. Shasta strain of rainbow trout (Salmo gairdneri) from a dietary level of 15 ppm was determined using a gas chromatograph equipped with an electron capture detector. The relative concentration (parts per million) of PCB's in the fish stabilized while absolute quantities (micrograms of PCB/fish) increased as the fish grew. The total retention of PCB's from the diet was 68% for a 32-week feeding period. The distribution of PCB's was fairly constant in the lipid portion of various tissues. PCB's did not appear to be eliminated from the trout after PCB exposure ceased even when the fish were starved. The fish did not appear to be adversely affected by the PCB's and no mortalities were attributed to PCB toxicity.

Liebig, G.F., Jr.

Arsenic.

In: Diagnostic Criteria for Plants and Soils. H. D. Chapman, ed. Quality Printing Company, Abilene, Texas, 1973. pp.13-23.

Key Words: arsenic, ponding/land application, land reclamation, groundwater, crops.

Abstract:

Plant and soil criteria useful in diagnosing arsenic status are described. Control of arsenic toxicity is discussed.

Liebmann, H.

Parasites in Sewage and the Possibilities of Their Extinction.

Advances in Water Pollution Research. 1964(2):269-288.

Key Words: parasitic worms, heat treatment.

Abstract:

In overcrowded Central European cities, unpurified sewage usually carries more than one million worm eggs into filter plants each day. In waste water of cities in Southern Europe, in Africa, Near and Far East, the number of worm eggs is even larger.

Chiefly, these worm eggs are spread by livestock. About 10 percent of worm eggs found in sewage originate in human feces. In Southern Europe and subtropical regions, the share of worm eggs spread by humans may reach more than 30 percent in sewage.

Extinction of worm eggs by means of chemicals has proven impossible.

The mechanical-biological method of destroying worm eggs in a purification plant is the only way to chose.

The entering phase in the extinction of worm eggs in the mechanical section of a filter plant is distinguished by a period of 2 hr for sedimentation, while the procedure of settling may be activated by flocking agents.

The second phase in destroying worm eggs in the mechanical section of a purification plant is stated in the process of sludge digestion. This period of digestion has to be of at least 3 months' duration in unheated digestors, while in heated ones a period of at least 2 months will succeed in the destruction of worm eggs.

Biological treatment will never destroy worm eggs.

In purification plants, cleaning sewage in the so-called way of complete mineralization, mature worm eggs get into the receiving water if intermediate installments for sedimentation, activated by flocking agents, before sewage will flow off are missing.

In methods of draining raw sludge, worm eggs will survive either in the sludge cake or in the straining water. As a matter of fact, drained raw sludge has to be burnt just as the straining water has to be subjected to the common mechanical purification.

In the process of draining sludge over sludge jolting sieves, a minor number of worm eggs are left in the sludge, while the major amount will invade the sludge water. This latter method raises considerable doubt as to hygiene if the sludge remaining in the jolting sieves is not burnt in turn, just as sludge waters released have to be subjected to the common mechanical process of purification.

Preliminary heating of digestant sludge will not kill worm eggs.

Interference on the development of worm eggs making use of rushes of alternating current must be omitted.

A short period of heating sludge to temperatures of more than 144°F will be successful in the extinction of worm eggs.

Lighthart, B. and A.S. Trisch.

Estimation of Viable Airborne Microbes Downwind from a Point Source.

EPA-600/2-76/020, U.S. Environmental Protection Agency, Corvallis, Ore., Ecological Effects Research Division, November 1975. 7p.

Key Words: viruses, bacteria, air, surface water (fresh).

Abstract:
Modification of the Pasquill atmospheric diffusion equations for estimating viable microbial airborne cell concentrations downwind from a continuous point source is presented. A graphical method is given to estimate the ground level cell concentration given (a) microbial death rate, (b) mean wind speed, (c) atmospheric stability class, (d) downwind sample distance from the source, and (e) source height.

Lijinsky, W. and S.S. Epstein.

Nitrosamines as Environmental Carcinogens.

Nature. 225(5227):21-23. January 3, 1970.

Key Words: nitrates, nitrites, surface water (fresh).

Abstract:

In summary, nitrosamines seem to be a major candidate class of carcinogens that are likely to be causally related to human cancer in industralized society. Nitrosamines act systemically and produce cancer in a wide variety of organs of many species. Additionally, individual nitrosamines exhibit marked organ specificity. Although methods for detection of nitrosamines lack sensitivity, their widespread environmental distribution has been demonstrated recently. Even more widespread and of possibly greater significance are the precursors of nitrosamines -- nitrites and secondary amines. These precursors react in defined conditions in vitro and probably also in vivo to form nitrosamines. Reduction of human exposure to nitrites and certain secondary amines, particularly in foods, may result in a decrease in the incidence of human cancer.

Lin, S.S. and D.A. Carlson.

Phosphorus Removal by the Addition of Aluminum (III) to the Activated Sludge Process.

JWPCF. 47(7):1978-1986. July 1975.

Key Words: oil and grease, BOD, COD, chemical treatment, effluent characteristics.

Abstract:

Domestic wastewater is a major contributor of phosphorus to receiving water bodies. Therefore, the removal of phosphorus from domestic wastewater is an essential step in abating nutrient enrichment of receiving waters. Because removal of the major portion of the phosphorus in domestic wastewater does not occur in the process of normal cellular growth of the sludge organisms during passage through activated sludge processes, it is not possible to use such biological treatment systems to remove large amounts of phosphorus from doemstic wastewater. The inability of the normal biological treatment system to remove phosphorus consistently from domestic wastewater has led to advanced wastewater renovation methods and modifications of the existing process.

Various processes for removing phosphorus from wastewater have been introduced. This paper emphasizes the addition of aluminum to the aeration tank of the activated sludge process. Aluminum salts were chosen rather than ferric or calcium salts, because the pH of minimum $AlPO_4$ solubility, about 6, is within the pH ranges for optimal microbial activity of activated sludge microorganisms.

Lindberg, S.E. and R.C. Harriss.

Mercury-Organic Matter Association in Estuarine Sediments and Interstitial Water.

Environmental Science and Technology. 8:459-462. May 1974.

Key Words: mercury, surface water (marine).

Abstract:

A sediment from the Florida Everglades and Mobile Bay Estuary reveal significant associations between Hg and organic matter and between dissolved Hg and dissolved organic carbon. Interstitial dissolved mercury is enriched from 2.6 to 36 times over the associated surface water values. Enrichment may be due to formation of organic and polysulfide complexes with mercury.

Lindell, S.S. and P. Quinn.

Shigella _sonnei_ Isolated from Well Water.

Applied Microbiology. _26_(3):424-425. September 1973.

Key Words: shigella, drinking and recreational water.

Abstract:
A method is described which led to the isolation of _Shigella_ _sonnei_ from well water suspected of being the primary focus in a school-associated shigellosis outbreak.

Lindsay, W.L.

Inorganic Phase Equilibria of Micronutrients in Soils.

In: Micronutrients in Agriculture. R.C. Dinauer, ed.
Soil Science Society of America, Madison, Wisconsin, 1972.
pp. 41-57.

Key Words: iron, manganese, zinc, copper, boron, ponding/land application, land reclamation.

Abstract:

Inorganic solid phases containing micronutrients in soils establish solubility limits for these nutrients. If the solution level of a nutrient drops below its equilibrium level, the solid can dissolve. Conversely, when the solution level exceeds the equilibrium level of a solid phase, it can precipitate. Thus, solid phases participate in the dynamic equilibria involving soil solution, soil exchange complex, adsorption surfaces, uptake and release of nutrients by microorganisms, and removal of nutrients by plants.

Unfortunately, many of the solid phases in soils containing micronutrients have not been well characterized. Rather than discrete crystalline minerals, these phases often consist of all gradations of amorphous solids with mixed matrices into which various micronutrients are incorporated. It is difficult to apply thermodynamic solubility relationships to solids of such variable composition. The difficulties are not insurmountable, however, and considerable progress is being made.

Lindsay, W.L.

Inorganic Reactions of Sewage Wastes with Soils.

In: Recycling Municipal Sludges and Effluents on Land; Proceedings of the Joint Conference, July 9-13, 1973. pp. 91-96.

Key Words: chlorides, nitrates, zinc, cadmium, lead, copper, nickel, chromium, mercury, cobalt, selenium, molybdenum, land reclamation.

Abstract:

Sewage wastes decompose in soils to CO_2, water, residual soil organic matter, and inorganic constituents. The more soluble elements, which are generally present as Na^+, K^+, Ca^{2+}, Cl^-, SO_2^{2-}, NO_3^-, and H_3BO_3, either remain in solution or exchange with ions on exchange sites on soil surfaces. Considerable technology is available on salt problems, ion exchange reactions, and movement of soluble salts through soils that can be applied to the application of sewage wastes to soils.

Another group of elements, which include Zn, Cd, Pb, Cu, Ni, Cr, Hg, Mn, Co, P, As, Se, and Mo, form compounds and reaction products of intermediate solubility. Under many soil conditions these elements are sufficiently soluble that they are taken up by plants and cycled into the food chain of animals and man. Recent developments in soil chemistry in the areas of mineralogy, chemical equilibria, and metal chelation offer many opportunities for critically and quantitatively studying the solid phase-soil solution equilibria. Such basic studies are needed to predict the long-term fate of potentially toxic heavy metals and other inorganic constituents that are added to soils by the addition of sewage wastes. Eventually these elements will find a new home in the mineral matrix of soils that will govern their availability to plants and their movement in soils.

Lindstedt, K.D. and E.R. Bennett.

Evaluation of Treatment for Urban Waste Water Reuse.

EPA-R2-73-122, University of Colorado, Boulder, Dept. of Civil and Environmental Engineering, July 1973. 146p. (Available from National Technical Information Service (NTIS) as PB-223 726).

Key Words: BOD, COD, ammonia, suspended solids, phosphates, bacteria, fecal streptococci, coliforms, activated sludge, chemical treatment.

Abstract:

The effectiveness of lime in reducing the concentration of bacterial organisms increases with dose and pH. At lime doses of 400 mg/l, fecal coliform, fecal streptococcus, and total coliform concentrations can be reduced by two orders of magnitude utilizing conventional clarification without chlorination.

Bacterial removals of about 90% can be achieved through alum clarification, irrespective of the alum dose.

Lindstedt, K.D. and E.R. Bennett.

Research Needs for the Potable Reuse of Municipal Wastewater.

EPA-600/9-75-007, University of Colorado, Boulder, Dept. of Civil and Environmental Engineering, December 1975. 203p. (Available from National Technical Information Service (NTIS) as PB-249 138).

Key Words: viruses, bacteria, total dissolved solids, synthetic/organics, pesticides, drinking and recreational water.

Abstract:

The objective of the workshop was to define and establish priorities for research needed to establish confidence in the reuse of wastewater for potable purposes. This objective was accomplished by bringing together 92 select persons concerned with wastewater reuse to discuss and identify research gaps in the areas of health effects, treatment technology, and the socio-economic considerations of potable reuse.

Lindstedt, K.D., E.R. Bennett, and S.W. Work.

Quality Considerations in Successive Water Use.

JWPCF. 43(8):1681-1694. August 1971.

Key Words: suspended solids, coliforms, arsenic, fecal streptococci, BOD, COD, phosphates, nitrites, ammonia, barium, cadmium, chromium, cyanides, fluorides, lead, selenium, aluminum, cobalt, copper, manganese, molybdenum, nickel, tin, zinc, influent characteristics.

Abstract:

This paper discusses generalities concerning reuse of wastewater. A tertial treatment system is proposed for potable water reuse. Constituent limitations are given for irrigation and potable water.

Lindstedt, K.D., C.P. Houck, and J.T. O'Connor.

Trace Element Removals in Advanced Wastewater Treatment Processes.

JWPCF. 43(7):1507-1513. July 1971.

Key Words: cadmium, chromium, selenium, COD, filtration, chemical treatment, adsorption/ion exchange, influent characteristics, effluent characteristics.

Abstract:

The system of lime coagulation and settling, sand filtration, activated carbon adsorption, and a cation-anion exchange sequence was very effective in reducing the concentrations of cadmium, chromium, selenium, and silver in secondary effluent. Of particular note was the high efficiency of activated carbon for reducing the concentrations of these elements.

The following conclusions may be drawn from this investigation:

1. Efficient removals of the trace metals cadmium, chromium, selenium, and silver, can be achieved with a strong acid--weak base ion exchange system.

2. Effective separation of the cationic-form trace elements studied may be realized with a lime coagulation-settling process.

Lingle, J.W. and E.R. Hermann.

Mercury in Anaerobic Sludge Digestion.

JWPCF. 47(3):466-471. March 1975.

Key Words: mercury, anaerobic digestion, influent characteristics.

Abstract:

Ten batch-operated digesters were inoculated with various quantities of phenyl mercuric chloride and mercuric chloride. Two concentration ranges were studied; digesters in the low range contained from 0.08 to 43 mg/l mercury (as Hg), and digesters in the high range contained from 1,451 to 2,200 mg/l mercury.

In all cases, the mercury was bound to or was associated with the solid matter in the digesters. Most of the mercury (96 percent) could be separated from the sludge by centrifugation and removal of the solids. The remainder of the mercury in the supernatant was almost entirely removed by filtration through a 0.45- m pore diam cellulose membrane filter.

Other filtration studies on centrifuged sludge supernatant showed that the mercury concentration in the supernatant was a linear function of the total solids concentrations, including concentrations that were non-inhibitory (1,560 mg/l) and inhibitory (2,200 mg/l) to the gas production of the digester.

The digester contents were analyzed for methyl mercury by a thin layer chromatography method. No methyl mercury was detected in any of the digesters.

Linko, R.R., P. Rantamaki, and K. Urpo.

PCB Residues in Plankton and Sediment in the Southwestern Coast of Finland.

Bulletin of Environmental Contamination and Toxicology.
12:733-738. June 1974.

Key Words: chlorinated hydrocarbons, surface water (marine).

Abstract:
In this article PCB residues (possibly from sewage sludge) are studied off the Finnish coast.

Literature Study of Selected Potential Environmental Contaminants, Titanium Dioxide.

EPA-560/2-75-001, Arthur D. Little, Inc., Cambridge, Mass., May 1975. 131p. (Available from National Technical Information Service (NTIS) as PB-242 293).

Key Words: titanium dioxide, direct contact, surface water (fresh).

Abstract:

A comprehensive review of the literature published since 1 January 1954 was conducted to prepare this preliminary report on the physical and chemical properties of titanium dioxide (TiO_2) on the environmental exposure factors related to its consumption and use, on the health and environmental effects resulting from exposure to TiO_2, and on the regulations and standards governing its use. Current problems include concern about the future availability of rutile ore to supply the increasing number of facilities using this ore in the chloride manufacturing process, and the disposal of the high volume of TiO_2 manufacturing wastes, particularly the spent sulfuric acid and ferrous sulfate from the sulfate manufacturing process. On the basis of reported information, TiO_2 does not pose substantial environmental hazard.

Liu, D.H.W. and J.M. Lee.

Toxicity of Selected Pesticides to the Bay Mussel (*Mytilus edulies*.

EPA-660/3-75-016, Stanford Research Institute, Menlo Park, Calif., May 1975. 111p. (Available from National Technical Information Service (NTIS) as PB-243 221).

Key Words: herbicides, pesticides, surface water (marine), shellfish.

Abstract:

1. The insecticide Sevin is toxic to the bay mussel at concentrations lower than its estimated solubility in seawater. Toxic effects were observed in adults as well as in larvae.

2. Although adult mussels can tolerate exposure to a saturated solution of Treflan, they appear to be able to detect extremely low levels of this herbicide. Embryo shell development is not affected by Treflan at a concentration half that of its estimated solubility in seawater; however, larval growth and metamorphosis are reduced.

3. Adult mussels can tolerate and do not appear to detect methoxychlor concentrations approaching twice the estimated solubility of this insecticide in seawater. Mussel eggs incubated in a saturated solution of methoxychlor develop normally; however, larval growth is depressed, and metamorphosis is inhibited.

Liu, D.L. and B.J. Dutka.

Biological Oxidation of Hydrocarbons in Aqueous Phase.

JWPCF. 45(2):232-239. February 1973.

Key Words: synthetic/Organics, surface water (marine).

Abstract:

The cell-free extracts prepared from the n-decane-Indulin C grown cells were more active in the oxidation of n-decane than the corresponding cells that had grown on n-decane alone. The hydrocarbon oxidizing enzyme displayed its greatest activity at pH 7.0 and could be precipitated by 30 percent ammonium sulfate. It also required a heat-stable, dialyzable 60 percent supernatant fraction and NAD for maximum enzyme activity. Ferrous, manganous, and calcium ions did not stimulate the enzyme activity.

Manometric and gas chromatographic analyses indicated that cell-free extracts of Culture S_{11} oxidized n-decane to n-decanol and n-decanoic acid, whereas partially purified enzyme preparations oxidized only n-decane to n-decanol. The n-decanol, n-decanal, and n-decanoic acid supported good growth for Pseudomonas desmolytica S_{11}, suggesting that they could be the intermediates in the n-decane oxidation. All the above findings indicated that the initial oxidative attack of hydrocarbon occurred at the terminal methyl carbon and required both oxygen and NAD.

It is suggested from these studies that the thiolignin, Indulin C, or other nontoxic surfactant may be used in the biological treatment of petroleum wastewater to accelerate the degradation of hydrocarbon and its derivatives by microorganisms. The biochemical engineering aspects of the utilization of Indulin C in the treatment of hydrocarbon water have been discussed previously.

Lockart, H.B., Jr. and R.V. Blakeley.

Aerobic Photodegradation of Fe (III) - (Ethylenedinitrilo) Tetraacetate (Ferric EDTA): Implications for Natural Waters.

Environmental Science and Technology. 9(12):1035-1038. November 1975.

Key Words: synthetic/organics, direct contact, surface water (fresh), surface water (marine), groundwater.

Abstract:

To determine the extent of ferric EDTA removal from the environment by interaction with sunlight -- i.e., photodegradation -- the behavior of aqueous solutions of ferric-1 C-EDTA at pH 4.5, pH 6.9, and pH 8.5 under irradiation from a wide spectrum 5500-W xenon arc lamp has been studied. Carbon dioxide, formaldehyde, N-carboxymethyl-N, N'-ethylenediglycine (ED3A), N,N'-ethylenediglycine (EDDA-N,N'), iminodiacetic acid (IMDA), N-carboxymethyl-N-aminoethyleneglycine (EDDA-N,N), N-aminoethyleneglycine (EDMA), and glycine have been identified as the major photodegradation products. No nitrilotriacetic acid (NTA) was detected during photodegradation. The rate of photodegradation was pH dependent, being most rapid at pH 4.5. At a light intensity of 4000-ft candles and an initial concentration of 0.0016M, Fe(III)-EDTA removal was complete after 24 hr of irradiation at either pH 4.5 or pH 6.9, and after 32 hr at pH 8.5.

Lockwood, R.A. and K.Y. Chen.

Adsorption of Hg(II) by Hydrous Manganese Oxides.

Environmental Science and Technology. 7(11):1028-1034. November 1973.

Key Words: mercury, surface water (marine), surface water (fresh).

Abstract:

The adsorption of Hg(II) by hydrous manganese oxides suspended in solutions with wide ranges of pH, chloride concentration, and ionic strength was studied to evaluate the possible importance of manganese oxides in mercury scavenging in natural waters. Manganese dioxide and possibly other oxides were precipitated with the addition of $MnSO_4$ solution to $KMnO_4$ solution. Low crystallinity was verified by X-ray. Hg(II) was adsorbed rapidly when added to aged suspensions of MnO_2 with low ionic strength. The equilibrium values in the pH range 6-8 fit a Freundlich isotherm:

$$[Hg(II)_{ads}]/[MnO_2] = 1.9 \times 10^{10} [Hg(II)_{soln}]^{1.73}$$

0.6M NaCl repressed adsorption below pH 9, but not above pH 10. Apparently 0.6 M $NaClO_4$ changed equilibrium values only slightly, but adsorption rates were many orders of magnitude lower, particularly above pH 8. The uncharged $Hg(OH)_2$ is the adsorbed species. $HgCl_2$ was also adsorbed, but not so strongly as $Hg(OH)_2$. It is concluded that MnO_2 may be important as a mercury scavenger in fresh or brackish water, either in the natural environment or in the treatment of water and wastewater.

Loehr, R.C. and C.T. deNavarra, Jr.

Grease Removal at a Municipal Treatment Facility.

JWPCF. 41(5):R142-R154. May 1969.

Key Words: oil and grease, gravity separators, activated sludge.

Abstract:

Twenty-four-hour composite samples over a six-month period, and hourly samples during a day were collected and analyzed to obtain information on (a) the removal of grease in specific units of a municipal treatment facility, (b) the overall removal of grease at such a facility, and (c) the relationships between the removal of grease, BOD, COD, and suspended solids.

The average influent grease concentration was 147 mg/l, which amounted to approximately 0.11 lb (0.05 kg)/day/cap. High grease concentrations were observed during periods of high wastewater flow.

The suspended solids in the effluent exerted about 0.43 mg/l 5-day BOD and 1.46 mg/l COD/mg/l of supsended solids in the effluent exerted 0.65 mg/l 5-day BOD and 2.2 mg/l COD/mg/l of volatile suspended solids.

No correlation was observed between the grease and suspended solids concentrations in the influent wastewater, plant effluent, and/or contact tank samples. A relationship was observed between the grease, 5-day BOD or COD of the influent wastewater, and plant effluent samples.

Logsdon, G.S. and J.M. Symons.

Mercury Removal by Conventional Water-Treatment Techniques.

JAWWA. 65(8):554-562. August 1973.

Key Words: mercury, adsorption/ion exchange, chemical treatment.

Abstract:

1. Mercury removal during coagulation was related mainly to adsorption of mercury onto the turbid-causing agents in the water.

2. In raw waters with low turbidity, ferric sulfate was more effective than alum for removal of inorganic mercury.

3. Removal by coagulation or adsorption on turbid-causing agents was less for methyl mercury than for inorganic mercury.

4. Inorganic mercury removal by softening was most effective in the pH range of 10.7-11.4 and is thought to be related to adsorption on magnesium hydroxide floc.

5. Methyl mercury was not removed by softening.

6. Removal by coagulation and softening showed little dependence on mercury concentration in the range of 3-16 μg/l.

7. Methyl mercury and inorganic mercury could be removed by both granular activated carbon columns and powdered activated carbon slurries.

8. Removal by activated carbon adsorption was a function of powdered carbon dose. To achieve adsorption for both inorganic and methyl mercury to a residual level of 2 μg/l Hg, 1 mg/l of powdered carbon was needed for each 0.1 μg/l Hg to be removed.

9. As long as environmental levels of mercury in raw water remain low (near the drinking water standards) extremely high removal percentages will not be necessary, and existing technology should be adequate for removing mercury.

Logsdon, G.S. and E. Edgerley, Jr.

Sludge Dewatering by Freezing.

JAWWA. 63(11):734-740. November 1971.

Key Words: suspended solids.

Abstract:

A beginning has been made in defining how fast sludge can be frozen with effective dewatering, and initial results indicate that a freezing speed of 60 min/hr may be effective. This possibility also lends encouragement to development of a continuous, mechanized freezing process.

Second, because compressive freezing is not needed for sludge dewatering, sludge could be frozen in thin layers on a flat surface. Freezing in this manner might be adaptable to mechanization and development of a continuous process.

Third, the studies suggest that sludges could be dewatered more effectively at higher freezing speeds when treated with a polymer that substantially lowers specific resistance. High concentrations of dissolved solids, on the other hand, could inhibit good dewatering.

Finally, natural freezing of sludge in lagoons in cold regions might be made more effective by spraying sludge through a nozzle about the size of a fire hose nozzle. Withdrawing sludge from a lagoon and spraying it back onto the lagoon surface could: (1) melt snow cover, (2) cool the sludge to freezing temperature as it travels through the cold atmosphere, and (3) distribute sludge in a thin layer on already frozen sludge, where it would freeze more readily. This procedure should substantially increase the dewatering capabilities of natural sludge freezing in some areas where it is now a marginal process.

Long, D.A. and J.B. Nesbitt.

Removal of Soluble Phosphorus in an Activated Sludge Plant.

JWPCF. 47(1):170-184. January 1975.

Key Words: phosphates, BOD, chemical treatment.

Abstract:

The foregoing results indicate that the chemical-biological process is capable of achieving low effluent phosphorus residuals concurrently with excellent BOD removals. Alum proved to be a more efficient precipitant than sodium aluminate in the system studied, and the best results were obtained when the alum was added at the effluent end of the aeration tank. Hydraulic overload was a chronic problem throughout much of the study. In addition to creating problems with loss of solids from the system, the variation in flow made it difficult to adjust chemical feed. It is recommended that automatic regulation of chemical feeders by flow meters be incorporated into plant design. Table VI shows the excellent phosphorus removals that were observed in the chemical-biological system under low flow conditions.

No greater differences in costs are apparent among the various process schemes using chemical precipitation for phosphorus removal that have been reported by others and the chemical-biological process represented herein. This similarity occurs because the chemical costs are virtually the same regardless of which process scheme is selected, and they represent the major portion of phosphorus removal costs. Costs are affected by the choice of chemical to be used. Generally, the least costly chemical that will give the required degree of removal should be chosen. Some cost advantage may be realized from the use of aluminum or ferric compounds as the precipitating agents rather than lime, because the dosages of the former are directly related to the phosphorus concentration, whereas those of the latter are not. There seems to be a definite cost advantage for the chemical-biological system when it is compared with a tertiary treatment system. Most of this advantage results from the lower capital costs for the chemical-biological process.

The problem of determining just what degree of phosphorus removal is necessary to control eutrophication in a particular instance still has not been resolved. The

stream standards that are now being established show widely varying requirements for phosphorus removal by specifying different levels for the various forms of phosphorus (such as filtered or unfiltered, ortho or total) for different situations. This makes it necessary to match unit process performance to a specific standard that may well change in the near future as the results of more research become available. A distinct advantage of the chemical-biological process is that varying phosphorus removal requirements can be easily met by controlling the amount of precipitating chemical added while still maintaining a high degree of organic removal.

Long, D.A., J.R. Nesbitt, and R.R. Kountz.

Soluble Phosphorus Removal in the Activated Sludge Process. Part I. Chemical-Biological Process Performance.

EPA-17010-EIP-05/71, Soap and Detergent Association, New York, May 1971. 122. (Available from National Technical Information Service (NTIS) as PB-211 563).

Key Words: phosphates, aluminum, BOD, chemical treatment, activated sludge, trickling filters.

Abstract:

It was the objective of this research to develop and evaluate, at full plant scale, the combined chemical-biological process of phosphorus removal. The research was conducted in two major investigative phases using the final aeration and settling ranks of that portion of the Pennsylvania State University Wastewater Treatment Plant which treats wastewater from the PSU campus.

The Phase I investigations indicated an Al/P (filt. ortho) weight ratio of 2.25/1 was necessary to reduce the influent phosphorus of approximately 10 mg P/1 to approximately 0.3 mg P/1 in the filtered effluent. Alum proved to be a more effective precipitant than sodium aluminate in the moderately alkaline wastewater available for this study. The best results were obtained when the chemical was added at or near the effluent end of the aeration tank.

Long, W.N. and F.A. Bell, Jr.

Health Factors and Reused Waters.

JAWWA. 64(4):220-225. April 1972.

Key Words: viruses, bacteria, surface water (fresh).

Abstract:

Much work remains to be done regarding the determination of viral and bacterial disinfection of waters and the effects of "agent X" before direct consumptive reuse of waste waters can be sanctioned.

Longley, K.E., V.P. Olivieri, C.W. Kruse, and K. Kawata.

Enhancement of Terminal Disinfection of a Treatment System.

In: Virus Survival by Water and Wastewater Systems. J.F. Malina, Jr. and B.P. Sagik, eds. University of Texas at Austin, Center for Research in Water Resources, 1974. pp. 166-179.

Key Words: viruses, chlorination, ozonation.

Abstract:
The following conclusions were reached:

1. Conventional disinfection practices using chlorine not produce substantial virus removal in wastewater at the doses reported.

2. Ozone, while being an excellent viricide in wastewater, does not yield significant bacterial removal at the doses reported.

3. At the same dose, chlorine gas, when applied under controlled mixing conditions to wastewater, appears to be a better disinfectant than a chlorine solution.

4. Excellent viral and bacterial removals can be achieved quickly in wastewater with chlorine by reducin the reaction pH. However, in many instances the effluent pH then must be raised to meet receiving strea standards.

5. Substantial viral and bacterial removals may be achieved by chlorination of wastewater under highly turbulent, plug flow conditions.

6. The pH of the aqueous chlorine stream and the mixed stream are critical disinfection parameters.

Lothrop, T.L. and O.J. Sproul.

High-Level Inactivation of Viruses in Wastewater by Chlorination.

JWPCF. 41(4):567-575. April 1969.

Key Words: polio virus, viruses, chlorination.

Abstract:

The following conclusions can be drawn from this study:

1. High-level inactivation of viruses can be obtained in treated and untreated domestic wastewaters. Present chlorination practices (one mg/l of residual), however, are totally inadequate for a high level of virus inactivation.

2. A combined chlorine residual of 28 mg/l (measured amperometrically) was required to produce a 99.99-percent inactivation of the T2 bacteriophage in settled raw wastewater after a 30-min contact time.

3. A combined chlorine residual of 40 mg/l (measured amperometrically) was required to provide a 99.99-percent destruction of the Type 1 poliovirus in settled wastewater (30-min contact time).

4. Free chlorine residuals of 0.2 to 0.4 mg/l, after 30 min, produced a complete inactivation of the poliovirus and T2 phage in the secondary effluent.

5. In the experimental runs with the synthesized stormwater overflow samples 100-percent inactivation of the Type 1 poliovirus was obtained by providing a tree chlorine residual.

6. The T2 bacteriophage was much less sensitive to combined chlorine residuals than is the coliform organism and somewhat more sensitive than the poliovirus to combined chlorine residuals.

7. The use of ORP measurements as an indication of the viracidal activity of chlorine was of limited value in disinfection programs which utilize combined chlorine residuals.

Lowndes, M.R.

Ozone for Water and Effluent Treatment.

Chemistry and Industry. 34:951-956. August 21, 1971.

Key Words: viruses, coliforms, ozonation.

Abstract:

The conclusions that can be drawn by water engineers and chemists from experience at recent full-scale ozonization plants can be summarized as follows:

1. The objection to the use of ozone on account of the rather poor performance of mechanical equipment for its production has now been entirely overcome, mainly by the use of materials and techniques that were not available twenty years ago.

2. Costs for producing ozone have been greatly reduced over the last decade and should be reduced further during coming years as efficiencies of production are increased.

3. The effectiveness of ozone as a bactericidal agent cannot be doubted provided application techniques are followed which ensure that the "threshold" value for any particular water has been exceeded.

4. The effect of ozone on viruses is striking and often its germicidal power is found to be more pronounced against those organisms that seem to be more resistant to conventional disinfection techniques.

5. The efficiency of ozone is not greatly affected by the presence of ammonia or changing pH value.

6. Ozone has been effectively used in many cases for the elimination of tastes and odors, especially those derived from phenolic wastes and algal contamination.

7. Consumers have often been quick to notice the improvement in water after the start-up of ozonization plants on account of the noticeable "freshness" and the removal of color of the supply.

8. Ozone treatment leaves water with no residual other than an almost complete dissolved oxygen content.

Ludzack, F.J. and D.K. Noran.

Tolerance of High Salinities by Conventional Wastewater Treatment Processes.

JWPCF. 37(10):1404-1416. October 1965.

Key Words: chlorides, activated sludge, nitrification/denitrification.

Abstract:

1. Detectable changes in sustained performance of activated sludge were not observed below chloride concentrations of 5,000 to 8,000 mg/l. Temporary clarification problems were observed.

2. Low load ratios and high unit solids increased activated-sludge tolerance to chloride changes and high-chloride concentrations.

3. A given change in activated-sludge chlorides resulted in a better overall performance when the change was made abruptly rather than incrementally.

4. Chloride changes disrupted clarification until substrate density stabilized.

5. Initial respiratory activity after a chloride change was equal to or greater than that of a reference sludge. Significant population variety and activity changes occurred later. Sustained high chlorides generally depressed respiration.

6. Periodic operation at low chlorides improved the tolerance of activated sludge to high chlorides.

7. High-chloride operation was characterized by poor flocculation, higher effluent solids, and about 10 percent loss in oxygen demand removal efficiency.

8. Nitrification during high-chloride operation was about 10 percent of that expected for the same operation at low chlorides. It required several hours of high-chloride operation to inhibit nitrification and several days to reestablish good nitrification after reducing chlorides.

Anaerobic Digestion

1. Anaerobic digesters were much more sensitive to chlorides than activated sludge units were.

2. Digester performance losses at a given chloride concentration were greater with a more rapid increase in chloride concentration.

3. A given chloride increase frequently exerted delayed effects, with performance decreases occurring after steady-state performance normally would have been established.

4. Chloride effects on digestion were greater at higher load ratios.

5. Biota adaptation to chloride changes required more time and were more limited in scope than similar changes in activated sludge.

6. Aerobic digestion is likely to be more effective than anaerobic digestion for excess sludge stabilization when operating on high or varying salinities.

Lund, E.

Inactivation of Viruses.

Progress in Water Technology. 3:95-97. 1973.

Key Words: viruses, drinking and recreational water.

Abstract:

There are a number of natural or man-made ways of rendering viruses innocuous, but the reactions are often much slower than would be desirable and the actual reactions in most cases virtually unknown. In all those situations where waste-water is the raw material for drinking water this is potentially a very difficult situation and work on virus inactivation should be encouraged.

Lund, E. and C.E. Hedstrom.

The Use of an Aqueous Polymer Phase System for Enterovirus Isolations from Sewage.

American Journal of Epidemiology. 84(2):287-291. 1966.

Key Words: viruses, epidemiology.

Abstract:

The Albertsson two phase system of aqueous polymers was used for concentration of virus from sewage. This concentration procedure proved as efficient in a simple one step procedure as a combined ammonium sulfate-ultra-centrifugation procedure for the concentration of enterovirus. From June to December virus was detected in 40 samples. In 15 cases the virus was demonstrated in unconcentrated material. If both bottom-phase and inter-phase were tested the number of virus isolations was 38. In 6 cases different types of virus was found in the two phases.

Lund, E., C.E. Hedstrom, and O. Strannegard.

A Comparison between Virus Isolations from Sewage and from Fecal Specimens from Patients.

American Journal of Epidemiology. 84(2):282-286. 1966.

Key Words: viruses, coxsackie virus, epidemiology.

Abstract:

The Albertsson two phase system of aqueous polymers proved a useful tool in the detection of virus in sewage samples.

In spite of an accumulation of cases of echovirus 9 infections only a single isolation was made from sewage, and a number of cases of adenovirus 7 infections were not paralleled by isolations from the sewage system. Coxsackieviruses B were abundantly found in the sewage in the autumn of 1964. The same types of viruses were also isolated from clinical cases of aseptic meningitis. By means of 24 hour swab samples it was possible to detect the Coxsackieviruses B in the sewage system before any clinical cases of coxsackie B infections were reported.

Lund, E.L., C.E. Hedstrom, and N. Jantzen.

Occurrence of Enteric Viruses in Wastewater After Activated Sludge Treatment

JWPCF. 41(2):169-174. February 1969.

Key Words: viruses, polio virus, coxsackie virus, ECHO virus, adeno virus, effluent characteristics.

Abstract:

By improving the methods for isolations of virus, the presence of enteric viruses has been demonstrated all year round in raw wastewater.

The activated sludge process removed about 1.5 log units of virus from the wastewater, but the efficiency decreased at the end of the year. No effect of in-plant chlorination on the virus contents of the effluent was demonstrated.

Lutin, P.A.

Removal of Organic Nitriles from Wastewater Systems.

JWPCF. 42(9):1632-1642. September 1970.

Key words:
cyanides, activated sludge, effluent characteristics.

Abstract:

The purpose of this investigation was to study the efficiency of activated sludge treatment in removing organic nitriles from wastewater by the oxidative mechanism.

Mononitriles are toxic or very resistant to biological Oxidation at 6 and 24 hr. This refractory nature seems to decrease with increasing chain length.

Dinitriles are toxic or extremely resistant to biological oxidation for detention times up to 72 hr.

The molecules having a carboxyl terminal group are oxidized more significantly than the corresponding alkane or mononitrile.

Aromatic nitriles exhibited a toxic effect on all three sludges and, therefore, strongly resisted biological oxidation.

In general, presence of the cyanide group greatly reduces the susceptibility of a molecule to biological oxidation by an activated sludge.

The experimental results show that the Franklin sludge is able to oxidize mononitriles with four carbons or more to a significant extent in 72 hr. The Bordeaux sludge was very weak in its ability to oxidize organic nitriles below 11 carbons in chain length. Nashville sludge was able to oxidize only undecanenitrile.